Medical Myths, Lies, and Half-Truths: What We Think We Know May Be Hurting Us

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Dr. Novella received his M.D. from Georgetown University and went on to complete residency training in neurology at Yale School of Medicine. He is also trained in the subspecialty of neuromuscular disorders, which continues to be a focus of his practice. Although he treats all types of neurological disorders, he specializes in diseases of nerves and muscles.

Dr. Novella is the president and cofounder of the New England Skeptical Society, a nonprofit educational organization dedicated to promoting the public understanding of science. He is also the host and producer of their popular weekly science podcast, *The Skeptics' Guide to the Universe*. This award-winning science show (2009 winner of the People's Choice podcast award in the education category) explores the latest science discoveries, the presentation of science in the mainstream media, public understanding and attitudes toward science, philosophy of science, and critical thinking.

Dr. Novella was appointed in 2009 as a fellow of the Committee for Skeptical Inquiry, an international organization dedicated to the promotion of science and reason; he writes a monthly column for their publication, the *Skeptical Inquirer*. Dr. Novella maintains a personal blog, the award-winning *NeuroLogica Blog*, which is considered one of the top neuroscience blogs. On *NeuroLogica Blog*, he covers news and issues in neuroscience but also general science, scientific skepticism, philosophy of science, critical thinking, and the intersection of science with the media and society.

Dr. Novella is also the founder and senior editor of *Science-Based Medicine*—a group medical and health blog with contributions from dozens of physicians and scientists. *Science-Based Medicine* is dedicated to promoting the highest standards of both basic and clinical science in medical practice. This prolific health blog is geared toward both the general public and health professionals. *Science-Based Medicine* is recognized as a top health blog and is increasingly influential in the ongoing discussion of the role of science in medicine. ■

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Disclaimer

This series of lectures is intended to increase your ability to recognize medical misinformation and make use of reliable, evidence-based information when making health-related choices. These lectures are not designed for use as medical references to diagnose, treat, or prevent medical illnesses or trauma. Neither The Great Courses nor Dr. Steven Novella is responsible for your use of this educational material or its consequences. If you have questions about the diagnosis, treatment, or prevention of a medical condition or illness, you should consult a qualified physician.

Medical Myths, Lies, and Half-Truths: What We Think We Know May Be Hurting Us

Scope:

True or false: Eight glasses of water a day are mandatory for staying hydrated. Vitamin C protects you from catching a cold. Frequent snacking is the quickest way to bust your diet. Natural foods are always better for you.

You hear advice like this all the time. But what do these would-be nuggets of medical wisdom have in common? They're all myths, half-truths, and misconceptions—pieces of information so familiar that we take them for granted without considering the scientific truth about them.

In today's information age, when supposedly accurate medical advice and diagnoses can be found online with the click of a computer mouse, medical myths are all around us. Using them to make decisions about your health—whether it's how to treat the symptoms of the common cold or how to care for a child or aging relative—can be harmful, even deadly.

Because you are ultimately responsible for your own health, it's critical to understand the accuracy of medical information—to break down the growing body of misinformation and discover the truth about everyday health and well-being. These 24 lectures are an empowering learning experience that will give you evidence-based guidelines for good health, will enhance your ability to be better informed about common medical myths, and will strengthen your skills at assessing the scientific truth behind medical information and advice. ■

Medical Knowledge versus Misinformation

Lecture 1

There are hundreds of cancer cures promoted on the Internet. There are all kinds of concoctions and unusual or bizarre treatments that will sell themselves because of claims that there's a conspiracy of silence in the medical community—that the government and physicians are all in on it for some reason. But, at the end of the day, what they're trying to do is sell you on a myth of the hidden or secret cancer cure.

We are all responsible for our own health and health care and for that of our children. Yes, there are healing professionals who are there to help, advise, and perform technical procedures—like surgery—that we can't do ourselves. But, ultimately, we make our own decisions. We live in the age of information, where we can simply go on the Internet and get access to all the information that professionals have access to. Being armed with accurate information can help us make the best health decisions for ourselves and our families. But the flip side is that being confused by myths and misinformation can be dangerous—sometimes even deadly.

On the Internet and elsewhere, there are rumors, urban legends, and myths that are spread as fact. There are many ideological groups spreading misinformation to promote their particular worldview. There are also plenty of people who are trying to separate you from your money by making false or misleading marketing claims or using hype rather than real information to promote a product.

The best source of reliable information is still health-care professionals. Your physicians are there primarily to advise you. Don't be afraid to ask questions: When you have a visit with a physician or other health-care professional, come prepared. If you are going to do some research on your own, do it before you go in, and bring your specific questions. Bring a friend or family member, because the more people that are in the room hearing the information, the more you will remember. Also, don't be shy about seeking second opinions; it's pretty much par for the course these days.

There are other trusted sources besides health-care professionals. If you are wading through the information on the Internet, stick to trusted sources like known universities—Yale, Harvard, the Mayo Clinic, or Johns Hopkins. There are also many research institutions like the National Institutes of Health, the National Cancer Institute, and the Muscular Dystrophy Association. There are professional organizations for every specialty, like the American Academy of Pediatrics and the American Academy of Neurology. There are also patient or disease advocacy groups like the Multiple Sclerosis Society.

Don't be afraid to ask questions of your health-care providers.

But there are also a lot of posers. Anyone can create a snazzy website and make it seem like they're an impressive organization. Therefore, here are some red flags to look out for: Beware of so-called institutes or organizations that seem to be doing nothing more than promoting a single individual. Beware of sites that seem to be trying to sell you something; they are probably distorting information to make that sale. Also, beware of outliers. If you're visiting various sites that all seem to have one opinion, but Bob's Institute of Syndrome X has a completely different opinion, it's probably Bob's Institute that you should be wary of. There are also well-meaning but misguided patient and disease-oriented groups. There are groups that honestly want to do what's best for patients, sufferers, and society, but they don't have a culture of science.

Finally, there is no substitute for just thinking critically. At the end of the day, you have to think for yourself. Here are some more tips for reading information on the Internet: (1) If something sounds too good to be true, it probably is. If someone's promising you the cure for cancer, you should be a little wary of that. (2) Don't trust testimonials. They are just anecdotes, and as we say, the plural of anecdote is anecdotes, not data. Sites use testimonials to support their claims because they don't have the scientific evidence to back them up. (3) Look for contrary information and opinions. If someone is trying to sell you a product, treatment, or therapy, specifically go out of your way to see what the critics of this are saying. (4) Finally, is there published, peer-reviewed evidence? That's the ultimate currency of medical information. Having a peer-reviewed article is not a guarantee that the results will hold up over time or that they're accurate, but it's at least a good starting point. To search for this research yourself, go to the website PubMed.org.

The best source of reliable information is still health-care professionals.

Over the next 23 lectures, we're going to go on a journey together through many medical facts and myths. I will also discuss many controversial topics. Some of these topics may touch very close to home on beliefs that you have, and I ask you to listen with an open mind. My job is to go through the scientific literature, to try to make sense of the science as we understand it today. Sometimes that may lead to conclusions that are not necessarily popular or that are controversial. I also try to separate out real controversies within the scientific community itself from false controversies—ones where the scientific community is generally on the same page, but there are still public opinions that are contrary. I'll also try to make clear when I'm giving you my own opinion or interpretation that may not be the definitive answer on a particular problem. ■

Suggested Reading

Note: Additional references for most lectures are listed at the end of the Bibliography.

Bausell, *Snake Oil Science*.

Centers for Disease Control (website).

Ernst and Singh, *Trick or Treatment*.

Mayo Clinic Online Reference.

Sagan, *The Demon-Haunted World*.

Sampson and Vaughn, *Science Meets Alternative Medicine*.

Science-Based Medicine (blog).

Questions to Consider

1. How do we know which treatments are safe and effective for which conditions?

2. What role do you think informed consumers should play in their own health care?

Myths about Water and Hydration

Lecture 2

So-called juicy foods like fruit contain a great deal of water, maybe 60%–70%. There are some surprising foods, like a cooked hamburger, that have 40%–50% water.

About 65% of the adult body by weight is made up of water. We all need water to survive, yet there are many misconceptions and much false information out there about this most basic element of life. How much water should we drink every day? If you are dehydrated, should you drink beverages with caffeine in them? Are expensive water purifiers really worth it?

The primary mechanism by which we maintain our hydration is thirst. Thirst is a powerful emotion that motivates us to eat and drink. Thirst actually serves two functions. First, it regulates the concentration of salt and other electrolytes in our blood—a property of the blood and tissues called osmolality. Also, it regulates the overall volume of water in our bodies. The other primary mechanism by which our bodies regulate our own fluid is urination. Many people ask how useful urine color is in determining our overall state of hydration. It turns out that it's actually a pretty good rough marker.

Another way our body loses water is through sweating. Sweating primarily is a mechanism to regulate body temperature, but it involves excreting saline from our sweat glands. In hot and dry environments or with physical activity, sweating can be a significant source of water loss. This may dramatically increase the amount of fluid we need to drink in order to replace what we lose through sweat.

One of the big myths of water is how much water we should drink every day. Typically, you'll hear that you need to drink eight 8-ounce glasses of water per day. This myth probably originates from the Food and Nutrition Board, which calculated the average water needs of an average adult with average activity and environment and came up with the figure of 64 to 80 ounces per day. However, in that same report, they also noted that most people get 20% of their fluid intake from food. Thus, even if you need 64 or 80 ounces, you don't have to drink it all as water, and you don't have to go out of your way to count up how many glasses of water you're drinking.

What about thirst myths? I've often heard that by the time you're thirsty, it's too late—you are already dehydrated. When you think about it, that doesn't really make much sense, because thirst has evolved over millions of years to be a mechanism to tightly regulate how much fluid we need in our body. It wouldn't work well if you didn't become thirsty until after it was too late. In general, you can rely on your thirst. You will become thirsty long before you are actually dehydrated. Thirst works, and you don't have to force fluid when you don't feel like drinking.

The diuretic effect of caffeine is actually very mild, and the fluid in most caffeinated beverages will more than compensate for this effect.

What about the myth that caffeinated drinks do not hydrate and in fact will make your hydration worse? This is based on a kernel of truth, as many myths are. Caffeine is a weak diuretic; therefore, if you drink a lot of caffeine, it could plausibly make you lose fluid. However, the diuretic effect of caffeine is actually very mild, and the fluid in most caffeinated beverages will more than compensate for this effect. If you're out on a hot summer day and all you have is a caffeinated beverage to drink, go ahead and drink it. It will still hydrate you.

What about special situations in which we need to pay more attention to our hydration? In hot weather, we sweat more to cool ourselves off, and we therefore lose more fluid. Whenever you're in a warm or hot environment, make sure you have access to fluid so that you can hydrate continuously. Fortunately, our bodies also acclimate to a hot situation by holding onto more fluid. Athletes often push human endurance to its limits, and water is no exception. Athletes can lose as much as 2 liters of sweat per hour. That means they may need to drink 12 liters of fluid in a day in order to just maintain their hydration.

However, there's a cautionary downside to this as well. Aggressively hydrating, even with sports drinks that contain electrolytes, can actually worsen the dilution of electrolytes. The only way to really maintain your osmolality when you're drinking that much fluid is to eat salty snacks. When you push the body to its limits with extremes of athletic endurance, you overwhelm the regulatory systems. You have to be careful about how much you drink, what you drink, and that you eat.

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In a warm environment or with physical exertion, make sure you hydrate continuously.

There are a few questions that frequently come up with respect to water. One is bottled water—is there an advantage to it? Interestingly, bottled water costs about 1900 times as much as tap water. But bottled water, if you look at it statistically, is no better than tap water. It's no more healthy, and in taste tests, it hasn't been shown to taste any better. Bottled water, overall, is basically a scam.

What about water purifiers, which you install in your home to filter out organisms, impurities, or heavy metals from your water? Most modern industrialized countries have agencies, like the Environmental Protection Agency in the United States, that closely monitor and regulate water. Currently, there are no major safety issues with tap water in the United States or other industrialized countries. If you have any concerns, you can look up these agencies' reports on the quality of the water in your area. The legitimate use for water purifiers is to increase the taste of water. There, you can just follow your own taste. If your tap water tastes fine to you, then don't worry about it. If it doesn't taste right, you may want to get a water purifier—even though it won't necessarily be more healthful. ■

Suggested Reading

Segal, “Body Fluids.”

Questions to Consider

1. How does the body maintain its delicate balance of water and electrolytes?

2. Are some sources of water better for hydration than others?

Vitamin and Nutrition Myths

Lecture 3

Even in ancient history, people understood that there was some connection between nutrition, the food that we eat, and health. For example, the ancient Egyptians wrote about the fact that liver could be used to cure night blindness. Although they didn't understand at the time that it's because liver contains vitamin A, they were treating a vitamin A deficiency.

One of the most common concerns patients have is about vitamins. Should they take a multivitamin every day, or can they get all the nutrition they need from the food they eat? Vitamins are those nutritional substances that are essential to health in tiny amounts but that an organism cannot manufacture in sufficient quantities itself. Therefore, you have to get vitamins from food.

Vitamins are only part of the nutritional content of food that we need to be concerned with, the micronutrients. Then there are the macronutrients, those parts of food from which we get calories or energy and also structural components, the stuff that we actually build our bodies out of. The three main types of macronutrients that we get in our diet are carbohydrates, lipids, and protein. Food also contains minerals, including calcium, phosphorus, magnesium, iron, zinc, copper, sodium, and potassium.

The best way to get good nutrition is through a well-balanced, varied diet.

So how do we get optimal nutrition? There is general agreement in the scientific community that the best way to get good nutrition is through a well-balanced, varied diet. You should avoid highly restrictive or narrow diets that are dependent on just a few different kinds of food. The USDA food pyramid goes over the rough proportions of different types of foods that would be contained in a healthful diet. A healthful diet should contain and should emphasize the following:

- You should eat about 2 cups of fruit and 2.5 cups of vegetables per day. Try to pick from the different subgroups of vegetables, including dark green vegetables, orange vegetables, legumes, and starchy vegetables.

- You should get 3 or more ounce equivalents of whole grain products per day, with the rest of your carbohydrates coming from either enriched or whole grain products.

- You should have 3 cups per day of fat-free or low-fat milk or equivalent milk products.

- To round out your diet, you should get protein from lean meats as well as eggs, nuts, and legumes.

Do we need to take vitamins every day? The big vitamin myth is that taking a daily vitamin is important for everyone's health and well-being. In fact, there is no evidence for any health benefit of routine supplementation. This is a very difficult question to study, but there have been observational studies that found no correlation between routinely supplementing with vitamins and health outcomes. Further, studies that show health advantage or a good outcome based on nutrition are only able to link those advantages to eating healthy foods—not to taking supplements.

So far, we have been talking about supplementation for healthy people with no medical conditions. But what about subpopulations? Children have increased nutritional needs because they're growing. Should we routinely give children vitamin supplements? It's probably still the best recommendation, based upon the evidence, that what's most helpful for growing kids is a healthy diet. But I know how difficult it is to get kids to eat their vegetables. If your children have a restrictive diet despite your best efforts, it is reasonable to consider supplementation as nutritional insurance.

Pregnancy is another situation in which there are increased nutritional demands. It is routinely recommended for pregnancy—and for women who are planning on possibly becoming pregnant—to take a prenatal vitamin because you need to boost your nutritional reserves before you know that you are pregnant. There are also a number of medical conditions in which our nutritional needs may be greater than at baseline and where supplementation may be beneficial. And there are specific conditions or diseases in which there isn't a deficiency, but taking extra vitamins may actually improve symptoms or outcome.

The best way to get good nutrition is through a well-balanced, varied diet.

Vitamins are, by definition, essential to nutrition to prevent deficiencies and improve many medical outcomes. But I want to emphasize that we need to avoid the myth that if some vitamins are good, then more must be better. This has led some to recommend very high doses, sometimes called megadoses, of vitamins. There is no theoretical reason, nor is there any evidence, to support the safety or the health effectiveness of megadosing. It is not recommended. Aside from the possibility of overdosing toxicity, regularly supplementing with high doses of certain vitamins actually correlates with an increased risk of certain diseases.

The best advice is to keep it simple: Don't get overwhelmed with the complexity of the different types of nutritional advice that people are willing to give. A few simple rules are enough. Eat a variety of foods; eat plenty of fruits and vegetables. For most people in most situations, you will be in perfect health in terms of your nutrition. ■

Suggested Reading

Eades, *The Doctor's Complete Guide to Vitamins and Minerals*.

Shils et al., *Modern Nutrition in Health and Disease*.

Questions to Consider

1. Should everyone be taking vitamin supplements?
2. What is the best way to achieve healthful nutrition?

Dieting—Separating Myths from Facts

Lecture 4

You don't want to get involved in some kind of elaborate scheme that you're not going to be able to really maintain long term, like counting every single calorie. It's better to use something that is simple and easy, that you can do every day for the rest of your life, and that will help you estimate and keep general track of how many calories you're eating. This includes just writing down what you eat. If you do that—just record what you eat—that helps people lose an additional 10% or 20% of weight.

Do you want to know the secret to weight loss? There are quite a number of self-help books, videos, and other products all trying to sell you that secret. How many times have you heard the claim "lose weight without diet and exercise?" This lecture examines diet—what we eat, what we should eat, what we perhaps shouldn't eat, and how much we eat.

How many calories does an average person need on an average day? That depends on a number of variables, specifically height, weight, age, and level of activity. An average man needs to eat about 2500 calories per day in order to balance his energy expenditures; an average woman, around 2000 calories. Of course, somebody with a very high degree of activity or someone above average in size may need to eat as many as 3000 calories in an average day.

Basal metabolic rate measures how many calories we burn going about our business. This is calculated based on our height, weight, and age. The basal metabolic rate increases with increasing height and weight and decreases with age. You also have to adjust the basal metabolic rate for activity level. Somebody who is sedentary isn't going to burn as many calories as somebody who is highly active. Putting all those factors together can allow you to roughly calculate how many calories you burn each day.

Weight management simply comes down to calories consumed versus calories expended. Overeating by as few as 50 calories per day can result in as much as 5 pounds gained per year. That's a lot of weight gain for a very tiny difference in our eating habits. So what if you want to lose some excess weight? A conservative approach to weight loss is underconsuming—consuming fewer calories than you burn by about 500 per day. If you underconsume by 500 calories per day, that's 3500 calories, or 1 pound, per week. One pound per week is a good, healthy rate of weight loss.

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Sensible eating and regular exercise are the best ways to maintain a healthy weight.

At the more aggressive end of the spectrum would be underconsuming by about 1000 calories per day. Most people cannot sustain that significant a decrease in their daily food intake for any period of time. Even still, underconsuming by 1000 calories per day only results in a weight loss of about 2 pounds per week. What this also means is that, if someone is claiming you can lose 5, 10, 15, or 20 pounds in 1 or 2 weeks, they're being less than honest. You can only burn about 1 to 2 pounds per week of fat, which is what you want to lose when you're trying to lose weight. Any weight loss above and beyond that is water weight or other things.

Lots of people claim to have tricks and tips for losing weight. Unfortunately, none of them are terribly helpful. One you may hear about is fasting, jump-starting a diet by fasting for a day or longer. There's really no evidence for any long-term or significant benefit from fasting, and it shouldn't be part of a weight control or weight management program. In fact, fasting may cause your body to try to conserve calories and lower its metabolic rate.

What about late-night eating? A lot of people give the advice that you shouldn't eat late at night if you're trying to lose weight because those calories turn directly into fat. This has been studied multiple ways in both animals and humans. It turns out that it really doesn't matter when you consume your calories; the net calories will still be stored if you have excess calories. It still comes down to calories in versus calories out.

What about restrictive diets? A lot of fad diets or weight loss diets are premised on the notion that if you eliminate certain things from your diet, the weight will magically melt away. This is not a helpful strategy or a helpful approach to weight loss. In the final analysis, it doesn't really matter what kinds of calories you're eating; the overwhelmingly important factor is how many calories you're eating. Also, by restricting the variety of food that you eat, you can compromise good nutrition.

Exercising definitely burns calories, but not as many as you may think.

In the last 20 years or so, there has been a huge fad of diets focused on either low fat or low carbs. The notion here is that if you adjust the proportion of macronutrients—fats, proteins, and carbohydrates—in your diet, you will get to some magical zone or magical balance in which you'll shift into a different kind of metabolism that will help you burn calories. After a lot of research, it turns out that there just isn't evidence to support these claims. It all still comes down to caloric intake.

I've spoken a lot about food and how much we eat. What about exercise? Isn't exercise important for weight loss? It turns out the answer is yes and no. Exercising definitely burns calories, but not as many as you may think. A reasonable exercise program is to do 30 minutes of cardiovascular exercise 3 days a week. That would burn about 450 calories. If you're trying to underconsume by 3500 calories per week in order to lose 1 pound per week, then burning off an extra 450 calories doesn't get you very far toward that goal. The bottom line is that you can't lose weight solely by exercising. You would have to exercise 90 minutes a day, 7 days a week, in order to burn off 1 pound per week. Thus you have to combine exercise with calorie control.

What about diet pills—is there any medicine or pill that will help in a weight loss program? There's no theoretical reason why there can't be a pharmaceutical, for example, that shifts us into more of a weight loss balance.

But nothing has been proven to be both safe and effective. That doesn't stop there from being many "weight loss pills" on the market that claim to melt away the fat without diet and exercise. I certainly wouldn't believe any of those claims.

The way I interpret that breadth of research is simple. Dieting doesn't work. Perhaps that's the biggest myth of all—that you can positively impact your weight maintenance by going on a diet. Rather, the focus should be on long-term, healthful strategies that you can maintain for the rest of your life. ■

Suggested Reading

Novella, "The Skeptic's Diet."

Rippe, *Weight Watchers Weight Loss That Lasts.*

Questions to Consider

1. Is there any way to achieve and maintain a healthy weight without diet and exercise?

2. What does the scientific evidence have to say about popular weight loss diets?

The Fallacy That Natural Is Always Better

Lecture 5

You could take a vitamin C molecule that is derived from rose hips and a vitamin C molecule that was synthesized in a laboratory. The chemicals are identical. There's no test you can do to distinguish one molecule from the other. Is one therefore natural and the other one not natural? If so, then what does that mean?

We all want the food that we eat to be wholesome and nutritious, the medication and supplements that we take to be safe and effective, and everything we come in contact with in our environment to be pure and safe. Often, the assurance that these things are true is covered by calling something natural. But what does it really mean to be natural?

Most people would assume that being natural means that it occurs in nature, which superficially is sound or reasonable. But what about a molecule that is manufactured or synthesized but is identical to a molecule that occurs in nature? Is the synthetic molecule natural because it's identical to a molecule that occurs in nature, or does its origin matter? Does the actual physical molecule itself, not just its chemical structure, have to derive from something natural like a plant or animal?

We can also consider degrees of processing. If you take something that derives from nature—a plant or an animal—and do stuff to it, is there any amount of processing that you can do that would make it pass over a fuzzy line into being no longer natural? What about, for example, just simple mechanical processing like chopping or grinding? And what about cooking, which changes the chemical structure of things to some degree? The point is there is no real clear demarcation line between something that is entirely natural and something that is completely artificial.

The deeper question here is what the implications are to human health of something being natural versus not. Being natural is no guarantee of being safe or healthful. There are many poisons in nature, including hemlock, cyanide, arsenic, and animal and insect venoms.

Many people use the notion of natural being better than synthetic as a justification for lifestyle choices even though the evidence may not support those choices. One group that takes the notion of being natural to a bit of an extreme is those who advocate eating raw food. They claim that raw food preserves the nutritious value and natural enzymes of food and that by cooking food, you are in essence killing the food. But scientific evidence does not support the claims behind this. For example, there are only minimal differences in the nutritional value of food that is raw versus lightly or even moderately cooked. Some advocates also claim that raw food is more digestible than cooked food. This claim also is not true. Some foods—like meats and starches—are easier to digest once they are cooked.

Another concern that comes under the banner of natural being better is the use of hormones in the production of meat, eggs, and milk. There are several kinds of hormones that are given to animals. Some are endogenous hormones—hormones that animals make for themselves ordinarily—and some are exogenous steroids. These hormones in meat have been banned in Canada and the European Union based on alleged health concerns. But

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Organic produce has not been shown to be more nutritious than conventionally farmed produce.

this is largely based on theory and the popular notion that hormones are not safe—it's not based on any scientific evidence. In the United States and elsewhere, use of these hormones is carefully monitored and regulated.

There are only minimal differences in the nutritional value of food that is raw versus lightly or even moderately cooked.

Another issue is the use of antibiotics to minimize infection in animals in industrial settings. Do these antibiotics pose any risk or threat to human health? One concern is that extensive use might increase the risk of bacterial resistance to antibiotics. This is a very legitimate concern: There may be an indirect concern for human health there.

What about irradiating food? Again, some people oppose the notion of passing radiation through food because it's not natural and may alter the food from its natural state. However, the radiation passes through the food; there is no radioactive material in the food itself. Irradiating food is very effective in preserving food because it kills most of the bacteria. Irradiation may break down some nutrients, but the overall effect on the food is similar to that of cooking. The Centers for Disease Control estimates that if we irradiated 50% of the meat and poultry in the United States, we could prevent nearly 900,000 cases of infection, 8500 hospitalizations, and over 6000 catastrophic illnesses resulting in 350 deaths each year. The effectiveness of irradiating food is really not in question, but most of the opposition to it seems to be based on the notion that it's altering food from its natural state.

A very big issue with the notion of natural is organic food. Is being organic ultimately an appeal to this naturalistic notion, or are there legitimate concerns about organic versus conventional farming? One question that comes up is whether organic produce is more nutritious than conventionally farmed produce. A 2010 review, in the *American Journal of Clinical Nutrition*, of the last 50 years of research showed that there were no significant differences in nutritional value and no health benefits from eating organic food. There were only 12 studies that were most important in this review, but the evidence we have so far does not show any health or nutritional advantage. ■

Suggested Reading

Fallacy Files, "Appeal to Nature."

Gardner, *Fads and Fallacies in the Name of Science*.

Novella, "All Natural Arsenic."

Questions to Consider

1. What exactly does it mean to be "all natural"?

2. Are foods more healthful if they are organic, raw, or not genetically modified?

3. Why do you think the concept of "natural" has such widespread appeal?

Probiotics and Our Bacterial Friends

Lecture 6

People come to appreciate the bacteria that occupy their bodies and the role that they play when they're exposed to antibiotics. After a long course, or sometimes even not that long a course, of what we call broad spectrum antibiotics—antibiotics that kill a lot of different kinds of bacteria—this normal flora of bacteria can be decreased. When that happens, we become more susceptible to infection.

You've probably heard the phrase "no person is an island." That may be truer than you realize, for we are intimately close with billions of bacteria that coat every surface inside and out of our bodies. Soon after the discovery of bacteria in the early 20th century, the biologist Eli Metchnikoff suggested that some of these bacteria might actually be important to our health—and that maybe we could alter human health by altering these bacteria. He spawned the field known as probiotics, which is the topic of this lecture.

One of the core myths I'd like to address is the notion that all bacteria are bad. People tend to think of bacteria as germs—things that cause disease—when that is mostly not true. There are millions of different bacterial species in the world. The vast majority of those bacteria are completely neutral to human health. A very small minority are pathological; they will cause disease. Another small minority are actually useful; they aid in digestion, for example.

Every surface of our body that's exposed to the environment, inside and out, is occupied with layers of bacteria. Collectively, these bacteria are called the microflora, or the microbiota. There are 2 basic beneficial effects of the microbiota that we focus on. The first is that it's critical to the immune system. The carpet of bacteria actually crowds out harmless bacteria by taking up all the space and all the resources. Bacteria also aid in digestion. Bacteria break down foodstuffs like complex carbohydrates. They not only eat it for themselves, but they also break it down in a way that then we can further break it down and digest it ourselves.

Can we influence the ecosystem of bacteria in our body with what we eat? That's the basic concept of probiotics. However, that concept is a bit flawed. The primary conceptual problem here is that the ecosystem is easily altered. In fact, it's not easy to alter it at all. It's very difficult for a new bacterial species to work its way into that ecosystem.

Concepts aside, what does the evidence actually show? Do probiotic products work for any specific indication? There are some indications for which a mild benefit has been shown for some probiotic products. However, that is only the case when treatment is given very early and consists of probiotics with high colony counts that contain several species.

Let's talk about some specific uses. One use is preventing or treating diarrhea resulting from antibiotics. It turns out if you have an infection with *C. difficile*, the evidence shows that probiotics are of no benefit. What about irritable bowel syndrome, a very common disorder? There is weak evidence of a mild benefit, but the best that researchers could say at this time is that more research is needed. Probiotics have also been tested in allergies. A 2008 systematic review of the evidence for a specific type of allergy called atopic dermatitis found only mixed results. Do probiotics work for *H. pylori*? There's preliminary evidence for a mild benefit, not by itself, but as what we call adjunctive therapy. If you're taking the other treatments that have been shown to be effective for *H. pylori* and add probiotics, you may have a mild advantage.

People tend to think of bacteria as germs—things that cause disease—when that is mostly not true.

Most of the probiotic market is actually for routine use. Here I think the evidence is pretty clear: If you're a healthy individual with your normal bacterial ecosystem, then eating specific types of live bacteria simply doesn't have any benefit. It also should be noted that we are constantly exposed to bacteria from our environment. Adding a few extra bacteria in a specific yogurt doesn't really add much to our environmental exposure to bacteria. The bottom line is there is no evidence for routine use. While probiotics and prebiotics are more hype than help currently, there is evidence that there may be some potential symptomatic benefit for specific medical conditions. We may be able to affect human health with the probiotic approach, but we're not there yet. ■

Suggested Reading

Crislip, "Probiotics."

Floch and Kim, *Probiotics*.

Questions to Consider

1. What is the role of friendly bacteria in human health?

2. Are there any proven uses for probiotics?

Sugar and Hyperactivity

Lecture 7

In fact—and this seems somewhat counterintuitive—because caffeine is a stimulant, it may improve attention and stimulate the frontal lobes to function a little bit better. It may, paradoxically, decrease hyperactivity or improve attention in children.

Every parent knows that kids have a ton of energy, and hyperactivity may just be a natural part of being young. But, in some children, it can actually be a disorder, a disability that hampers school performance and makes home life challenging. The search for a cause and a cure for excessive hyperactivity in kids has led down many blind alleys. It has led to an industry of self-help books leaving parents with a tremendous amount of information, including a lot of misinformation.

One of the biggest hypotheses—and perhaps the biggest myth dealing with childhood behavior—is the food hypothesis: Children behave the way they do because of the food that they eat. This notion that there's a link between food and hyperactivity goes back to the 1920s and has been controversial ever since. It was mostly popularized in the 1970s by Benjamin Feingold, who created the Feingold diet. This is a diet that removes many things, including food coloring, from children's diets to eliminate or reduce hyperactivity.

A comprehensive review of the evidence performed in the 1980s showed that there is no link between additives and food, and hyperactivity or behavioral changes. But a recent study showed a weak correlation between food coloring and parents noticing an increase in their child's activity. It is possible that there is a mild effect in a small subset, about 5%, of children.

There are also those who think that sugar is the culprit. Despite this common belief with its obvious source in casual observations that most parents would make, there is no link. There is no evidence to support a link between eating lots of sugar and any behavioral change.

What about allergies? I've had parents tell me that they think that their child has a food allergy, and that the allergic reaction is behavioral changes. Real allergies cause skin rashes, breathing problems, sleeping difficulty, and generally feeling under the weather. Allergies do not cause hyperactivity or other behavioral changes.

Attention deficit hyperactivity disorder, or ADHD, is diagnosed in children who are far enough to the hyperactive end of the spectrum that it begins to impair their ability to function at home, at school, and in other situations. ADHD is best understood as a relative deficiency of executive function in the brain. Executive function comes from our frontal lobes, which give us the ability to look at the big picture, to think about the consequences of our actions.

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No link has been shown between eating sugar and behavioral change.

How do we diagnose ADHD? There's no blood test. There's no MRI scan. There's no definitive objective biological test to say who has ADHD and who doesn't. With spectrums, there's no absolute objective place to draw the line. To meet the criteria for that diagnosis, children or adults need to have at least 6 specific symptoms. The symptoms need to be of at least 6 month's duration and present in 2 or more settings.

How common is ADHD? By the strict diagnostic criteria, about 3% to 8% of children can be diagnosed with ADHD. About 50% of them will continue to meet those criteria into adulthood. It is a bit of a myth that all children with ADHD will outgrow their symptoms; only 50% do. A claim that comes up frequently is that ADHD is overdiagnosed. I think it is important that we do due diligence to make sure that we're using our diagnostic criteria appropriately. This has been specifically studied. If ADHD were overdiagnosed, you would expect that the false positive rate would exceed the false negative rate. But in specific studies, they find that there's no difference. ADHD is actually not overdiagnosed, despite the very popular belief that it is.

Is ADHD overtreated? There is an increase in the use of medication over recent years, but studies have shown that this increase is mainly because previously underserved populations are now being treated. A higher percentage of people with ADHD are being treated.

While ADHD is a genuine disorder, it is also part of a spectrum of typical childhood behavior and is highly treatable. We have very effective methods of improving behavior and outcomes in children. There's also a lot that we've learned about what to do for your typical child who has the typical range of hyperactivity—the kind of thing that all parents deal with.

There are a great number of myths out there about what triggers hyperactivity. A lot of it revolves around food—sugar, caffeine, and food additives. These serve as a distraction from the truth, and this is one of the big downsides of myths. Misinformation is often more harmful than just ignorance. Parents focus their efforts on highly restrictive diets that are very difficult and that may cause more problems for their child. They are better off focusing on basic parenting skills, forming a working relationship with their children, and focusing on the behavioral modification techniques that have been effective for decades. ■

Suggested Reading

Hallowell and Ratey, *Driven to Distraction*.

MedlinePlus, "Hyperactivity and Sugar."

Questions to Consider

1. What is the evidence regarding the claim that eating sugar, or any food, makes children hyperactive?

2. What is the evidence to support the notion that ADHD is a real disorder?

Antioxidants—Hype versus Reality

Lecture 8

Basic science tells us what kind of directions we should go in with clinical research but ... can't be used to make clinical claims. More often than not, we're going to be wrong when we guess what the outcome should be based upon just our basic understanding of basic biochemistry and biology.

The term "antioxidant" has become a marketing term synonymous with healthful. But does the hype really hold up to reality? Will that green tea or Acai juice make you live longer and be healthier? Let's examine the biochemisty a bit. We have something called oxygen free radicals inside our body, going around destroying our cells and DNA. This may sound scary, but actually, they exist in an equilibrium. They serve some beneficial effects inside our bodies. For example, they are used by some cells of the immune system to attack and destroy bacteria and viruses. Oxygen free radicals are also used as chemical signals that trigger important functions inside the cell. Therefore, you wouldn't want to completely get rid of them.

Eating several servings per day of fruits and vegetables is associated with a decrease in cancer risk.

Because these oxygen free radicals are an unavoidable by-product of energy production in the mitochondria in all of our cells, it stands to reason we would have evolved mechanisms to sop up those oxidative free radicals and keep them from doing damage. Substances that do that are called antioxidants. There are a number of naturally occurring antioxidants in the body, including vitamins E and C and many specific enzymes. They exist in part to reduce these oxygen free radicals and keep the whole system in equilibrium.

What about eating antioxidants or taking supplements? Beginning in the 1990s, the possibility arose that cellular damage from oxidative stress was actually the underlying cause of not only normal aging, but also many neurodegenerative diseases like Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis (ALS). This was cutting edge and very interesting science. Many of us were very excited by the prospect that antioxidants in some dose would become very effective in slowing down the progression of these diseases, maybe even halting it.

The public perception that antioxidants are healthful and a net good for health has persisted—despite the fact that the scientific evidence just did not turn out that way.

It turns out that as we get older, we lose some of our naturally occurring antioxidant capacity. It makes sense that replenishing antioxidants would be beneficial. Also, the brain is particularly susceptible to oxidative stress because the brain consumes a lot of oxygen. It therefore produces a correspondingly increased amount of oxygen free radicals. However, it's possible—and this was raised as a cautionary concern—that the oxidative stress leading to cell damage may have been a secondary effect. It may not have been the primary underlying cause of cell death in these neurodegenerative diseases. In other words, it's just one of the many things that happen when cells are dying, not the original or underlying cause of those cells dying.

So what did that research show? For Parkinson's disease, in human trials, antioxidants had no detectable beneficial effect in preventing the development of the disease or slowing its progression. The story is very similar for Alzheimer's disease. Human trials showed mixed results at best; there wasn't any compelling evidence for benefit even at high doses. For ALS, too, the results were disappointing. Studies of vitamins E and C, especially in high doses, did not affect the outcome of the disease. The scientific community was humbled by this experience. We had every reason to think that antioxidants were going to be a huge cure for many serious illnesses. Yet 15 or 20 years of clinical research completely disappointed us.

What about cancer prevention? We think that oxidative stress may damage DNA, in turn leading to cancer. In fact, there is evidence that eating several servings per day of fruits and vegetables is associated with up to a 30% decrease in overall cancer risk and greater longevity.

Fruits and vegetables contain antioxidants; eating them helps prevent cancer and improves longevity. However, we can't necessarily conclude that it's the antioxidants that are doing this. The exact mechanism of this clear benefit from fruits and vegetables has yet to be determined. High antioxidants may be playing a role, but there are other variables as well. Perhaps there are other things in fruits and vegetables that are healthful. Perhaps people who eat fruits and vegetables engage in other activities that are healthful. Perhaps if you eat lots of fruits and vegetables, you're not eating as much of other kinds of foods that may increase your risk of cancer.

There are simply too many variables to know whether it's the antioxidants or what exact role the antioxidants are playing in cancer prevention. But one clue we have comes from antioxidant supplements. The research shows that taking antioxidant supplements does not decrease cancer risk. That would argue against antioxidants being the definitive factor.

The public perception that antioxidants are healthful and a net good for health has persisted—despite the fact that the scientific evidence just did not turn out that way. What's the bottom line of all this? There's no evidence to support the routine use of antioxidant supplements or so-called superfoods—like Acai, Noni, blueberry, or pomegranate juice—that are loaded with antioxidants. There's simply no evidence that taking pills or eating superfoods has any health benefit. The evidence keeps leading us back to the common wisdom that most of us know to be true: You should eat your fruits and vegetables—especially your vegetables—every day. ■

Suggested Reading

Denisov and Afanas'ev, *Oxidation and Antioxidants in Organic Chemistry and Biology*.

Novella, "Antioxidant Hype and Reality."

Questions to Consider

1. What role does oxidative stress play in health and disease?

2. Are there any proven risks or benefits to foods or supplements high in antioxidants?

The Common Cold

Lecture 9

The common cold has been with us, obviously, for a very long time. It was known to many of the ancient civilizations according to historical records. In fact, the Egyptians even had a hieroglyph for it.

The common cold is, well, common. We all get it, we want to prevent it, and we want to shorten its duration. Therefore, it's no surprise that myths about the common cold are just as common as the cold itself.

Probably the biggest myth is that cold weather causes the cold: You can't get a cold from being exposed to cold weather or being wet or being out in the rain. You need to get exposed to a cold virus in order to catch the cold. However, there's a separate question of whether being cold or wet makes you more susceptible to catching the virus if you are exposed to it. Largely speaking, the evidence for that is negative. But it's still slightly controversial.

It is generally recognized that the cold is more common in the winter. This is probably mostly due to the fact that in the winter months, kids are back at school. In essence, kids and their less than ideal hygiene make schools perfect breeding grounds for cold viruses. The viruses then spread to the rest of the population through multiple pathways.

What about vitamin C? You may have heard for years that taking vitamin C can either treat or prevent the common cold. But it's been researched for decades now and not shown much impact. Does it prevent you from catching the cold? The answer is very clearly no. What about decreasing the severity of the cold once you catch it? There, the answer is no as well. What about reducing the duration of the cold with vitamin C? Here the evidence is not as conclusively negative. It still is trending negative, but there is some weak evidence for a slight decrease in the duration of a cold by about a half a day—if you took vitamin C at the very beginning of the cold or were already taking it before you got the cold.

Herbal remedies have become popular for the common cold. A few years ago, Echinacea was the most common herbal remedy. But extensive clinical research in people with Echinacea clearly shows no benefit for either prevention or reduction of severity. What about other types of supplements—vitamins and minerals to help boost your immune system? One product in particular called Airborne is basically just a multivitamin. The notion of Airborne is that it will prevent you from catching a cold on an airplane. It turns out that there's really no theoretical basis for the notion that taking a short-term supplement will improve or increase your immune activity and make it more robust or better able to fight off a cold. There is no evidence to show that taking Airborne or any other multivitamin or supplements reduces either the risk of developing a cold or its severity or duration. It's also interesting to point out that Airborne has very high levels of vitamin A. If you take it as recommended, you actually will get what is considered to be an overdose of vitamin A.

You should also avoid exposure to people known to be sick, especially in the first 3 days of their illness when they have a fever.

Let's talk a bit about preventing the common cold. The most effective measure for preventing a cold is to avoid getting exposed to the virus in the first place. That means frequent hand washing with soap and water. That will clear the viruses or bacteria off your skin before you have a chance to infect yourself with them. You should also avoid exposure to people known to be sick, especially in the first 3 days of their illness when they have a fever. When you are sick or when you are around other people who are sick, avoid touching your eyes and nose. You also may avoid crowds when you are sick. That way, you'll do everyone a favor by not spreading the virus around. When you do have to sneeze or cough, do it into your elbow or a disposable tissue.

Dry air can also dry out the nasal mucosa making it more vulnerable to viruses. Using a humidifier—if the air in your environment or in your home is too dry—may actually reduce your risk of getting a cold in addition to making you more comfortable. Do not smoke: A history of smoking may increase the duration of a cold by an average of 3 days. Sleep deprivation generally runs down the body and makes you more susceptible to infections, including the cold. Finally, recent evidence suggests vitamin D may be helpful in preventing the cold.

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Contrary to myth, treating a fever with medicine will not interfere with your body's immune response.

What are the symptoms of the common cold? Most of the symptoms of the cold are actually not caused by the virus itself; they are caused by your immune system fighting off the infection. Should you treat the symptoms of a cold, or by doing so, are you suppressing your immune system's attempt to fight it off? If you reasonably treat your symptoms, your body can still fight off the infection without any problem.

Are there any over-the-counter medications you should keep on hand for when you get a cold? Certainly, you can have acetaminophen or nonsteroidal anti-inflammatory drugs, which means aspirin, ibuprofen, or naproxen. They will treat a fever, if you've got one. They are also analgesics, so they can reduce sinus pain, general discomfort, or the pain of a sore throat. What about cough suppressants? Interestingly, a lot of common products will mix together a cough suppressant and an expectorant. That makes no sense when you think about it. If you are having a somewhat productive cough and you want to get the phlegm up, then take an expectorant. But over-the-counter cough suppressants are really not very effective in suppressing a cough.

You can also adjust your behavior in order to reduce the symptoms of a cold. Drinking a lot of fluids will help prevent dehydration, including that of the mucous membranes. If you can eat, that will make you feel better as well. A good night's rest is also important in fighting off the infection, but there's no reason to stay bedridden. Finally, avoid smoking or exposure to smoke, as that can irritate and dry the membranes and extend the duration of symptoms in a cold. ■

Suggested Reading

Eccles and Weber, *Common Cold.*

Tyrrell and Fielder, *Cold Wars.*

Questions to Consider

1. Why is the common cold so common and yet so difficult to treat and prevent?

2. Is vitamin C, or any other food or supplement, effective in preventing the cold?

Vaccination Benefits—How Well Vaccines Work

Lecture 10

In 1796, British physician Edward Jenner coined the term "vaccination," derived from the Latin word *vacca* for cow. This is because he was using the cowpox vaccine in order to prevent smallpox.

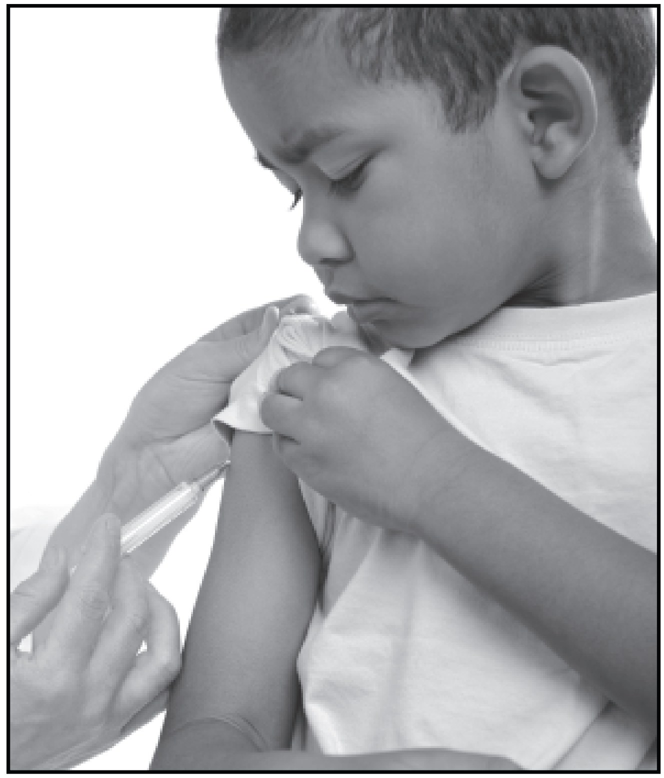
Myths, misconceptions, and resistance to vaccines are as old as the modern vaccine program itself. In fact, myths and misinformation seem to be increasing today in our society. This is threatening the effectiveness of the vaccine program as a public health measure. It's also making it difficult for individuals to make informed decisions for themselves and their families about vaccines. We explore how vaccines work and how effective they are.

Vaccines work by provoking a targeted immune response. A primary immune response—a response to something that your immune system is encountering for the first time—peaks at about 5 to 10 days. That's a long time for a virus or bacteria to be reproducing and spreading throughout your body. With a subsequent exposure, your immune system's response will peak in only 1 to 3 days. That means your body can fight off that infection much earlier and much more robustly.

There are different kinds of vaccines; the technology has actually advanced quite a bit in the last 100 years or so. The most primitive type of vaccines, called inoculations, utilized living viruses or bacteria and were essentially just a controlled infection. There was always the risk that the inoculation could cause a serious infection.

The next step was the development of the attenuated virus or bacteria. An attenuated vaccine uses the exact species or strain of virus that you're trying to inoculate against, but the virus is attenuated. The process of attenuation essentially is to breed it in another species so that it will be less virulent in humans. Your body will have time to fight it off, but you will develop immunity. The disadvantage to the attenuated virus vaccine is that it may back mutate.

The next type of vaccine is the inactivated vaccine. Here you take a virus or bacteria and essentially kill it. You inactivate it so that it cannot reproduce, but it still has all the proteins on the outside. There is a small risk of infection with an inactivated vaccine—but only if the virus is improperly inactivated. With proper inactivation, there is zero risk of infection. Inactivated vaccines may not be quite as effective as a live vaccine. For this reason, they are more likely to require booster shots.



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Modern vaccines are about 95% effective.

Then there are subunit vaccines. These contain not even an entire virus—just part of the protein shell, for example. Here, there is no risk of infection. Conjugate vaccines combine a toxin or an immunogenic protein to the coat, because certain coats are not very immunogenic. But, if you couple it with something else—a toxin or something that's really good at stimulating the immune system—the immune system will be activated against it.

Toxoid vaccines are vaccines not against the organism of a virus or bacteria, but against a toxin that the virus produces. Toxoid vaccines do not prevent an infection, but the antibodies will bind and inactivate the toxin as it's being released. Therefore, it will prevent the negative health consequences of the infection while allowing the infection to run its normal course.

Do vaccines work? There are still today people who question whether vaccines work. But the evidence is extremely clear: Vaccines are about 95% effective. This means that 95% of people who are vaccinated with a vaccination schedule—which may involve boosters—will develop a functional immunity to the substance against which they're being vaccinated. Vaccines are less effective in elderly and immunocompromised people. That is a serious concern because those are often the very people that we need to protect the most.

This leads us to the concept of herd immunity. There are estimates that when about 90% or more of any population—people who are likely to be exposed to each other—are vaccinated against an infection, you achieve herd immunity. That infection cannot easily spread from person to person. Anyone who is harboring the virus or bacteria is very unlikely to encounter somebody else who isn't immune. Therefore, they'll be able to fight it off before they spread it around. This prevents outbreaks and also prevents infections from being endemic. ■

Suggested Reading

Allen, *Vaccine*.

Henderson, *Smallpox*.

Questions to Consider

1. How do vaccines work?

2. How much evidence is there for the safety and effectiveness of vaccines?

Vaccination Risks—Real and Imagined

Lecture 11

Rumors began to spread that squalene in the vaccines given to Gulf War veterans was linked to Gulf War Syndrome. The gaping hole in this hypothesis, however, is that squalene was never even in the vaccines that those soldiers were given.

Continuing our discussion of vaccines, I'm going to turn now to talking about some myths about fears and about the safety of vaccines. We begin with a well-known myth about autism. A UK physician named Andrew Wakefield published a 1998 paper in *The Lancet* that claimed that he found a correlation between autism, which is a neurodevelopmental disorder; gastrointestinal disorders; and infection with the measles virus. The paper did not directly implicate vaccines. However, in the subsequent press conferences and media contacts that Wakefield had, he specifically spread concerns about the MMR (mumps, measles, and rubella) vaccine being linked to this gastrointestinal-autism disorder connection. MMR fears spread from that point for the following decade and beyond.

In the UK, vaccination rates with the MMR vaccine dropped from about 92% in 1996 down to as low as 84% in 2002. In some parts of London, compliance rates were as low as 61% in 2003. That's a dramatic decrease in the number of people willing to take the MMR vaccine or give it to their children. These rates are low enough that they're below herd immunity. That's that magic number of people who are vaccinated—around 90%—that prevents the endemic spread of an infection. This subsequently led to outbreaks of diseases that had been previously removed as endemic in the UK, such as measles. A similar thing happened shortly after that in the United States: The rates dropped, particularly in certain populations, and those populations became susceptible to previously eliminated diseases.

Wakefield was later found to have undisclosed conflicts of interest. He was actually applying for a patent for a replacement measles vaccine. He was also being funded by lawyers who were engaged in lawsuits on behalf of parents who were claiming that their children's autism was caused by the MMR vaccine. Even later, there were allegations made that the data in his original *Lancet* paper, or some of that data, may have been faked. This is because it didn't square with hospital records that were then re-reviewed. In 2010, based on these undisclosed conflicts of interest and these allegations, *The Lancet* actually withdrew his paper from the published record. Wakefield was found guilty of professional misconduct in the UK and no longer has a license to practice medicine there. However, the damage had already been done. Fears about a correlation between the MMR vaccine and autism were already spreading.

Independent studies in several countries found no connection between the MMR vaccine and autism.

A 2010 survey found that as many as 25% of U.S. parents think there is a link between vaccines and autism. In that same survey, 9 in 10 parents think that vaccines are important to the health of their children. This indicates that there's a certain amount of confusion in the general population about the safety of vaccines.

Ultimately the question of the safety of vaccines is not about the ethics or the research of one scientist; it's about the scientific evidence. There have been a number of studies on whether there really is a connection between the MMR vaccine and autism or other neurodevelopmental disorders. Data from Poland, the UK, Denmark, Finland, and Japan all independently found that there is no connection whatsoever between MMR and autism.

In the years following Wakefield, when research was progressively clearing MMR vaccine as a correlation with autism, those who were having fears about the MMR vaccine shifted to fears about thimerosal. Thimerosal is in some vaccines, but was never in the MMR vaccine. It is a mercury-based preservative added mainly to multidose vials or some inactivated vaccines to prevent bacterial contamination. It has been used for decades in many health and beauty products, not just vaccines.

I think of all the myths that I cover in this course, myths surrounding vaccines have the potential to do the most harm.

The question is whether the ethylmercury in thimerosal is toxic to people—and specifically to children—in the doses that you get from the vaccines. Mercury certainly is a neurotoxin; nobody denies that. The toxicology of mercury is pretty clear. However, autism does not resemble mercury toxicity. They're both neurological disorders, but the details of the signs and symptoms are different enough that we can say they're distinct disorders.

Over the last decade, there have been multiple studies in multiple countries looking at any correlation between exposure to thimerosal and the risk of developing either autism specifically or neurodevelopmental disorders in general. These studies have shown no correlation. Most significantly, in the United States the government decided to remove thimerosal almost completely from the routine childhood vaccine schedule. This removal was completed certainly by the beginning of 2002. The result of this was that the cumulative dose that children were exposed to from the entire vaccine schedule has been dramatically decreased. Those who were most vociferous about a connection between thimerosal and autism predicted that autism rates would plummet after the removal of thimerosal from the vaccine program. This did not happen. In fact, the autism rates continue to increase at exactly the same rate.

There are other vaccine myths that have cropped up as well. One myth is that we don't need to vaccinate against diseases that are no longer endemic. But the only time we can really safely stop using a vaccine is when a disease is worldwide eradicated. So far, that's only happened with smallpox. Others have raised fears that vaccines weaken the immune system, that natural immunity is better. However, that's actually not the case. Vaccines strengthen the immune system by providing a challenge to the immune system against a very particular antigen or group of antigens.

These myths are not benign. I think of all the myths that I cover in this course, myths surrounding vaccines have the potential to do the most harm. People want and need to be able to make informed decisions about their own health care and the health care of their family. When armed with the correct, science-based information, people can make very effective health decisions for themselves and their loved ones. ■

Suggested Reading

Novella, "Vaccines and Autism."

Offit, *Autism's False Prophets*.

Questions to Consider

1. Why do fears and misinformation persist about vaccines?

2. What are the real risks of vaccines?

Antibiotics, Germs, and Hygiene

Lecture 12

This is a war, if you will, that we are currently engaged in, the medical community. We are trying to preserve the effectiveness of our antibiotic armamentarium. Meanwhile, using antibiotics relentlessly is resulting in the development of more and more bacterial resistance—to the point that some fear we may enter what's called a post-antibiotic era.

We are awash in germs. Bacteria, viruses, fungi, and protozoa are all organisms that want to invade our bodies and cause infection. But we have evolved a defense against this—our immune system. We also have the advantage of technology, including antibiotics, that we can use to help our immune system in this fight.

There are several antibiotic and germ myths. The big one is that antibiotics work against many different types of infections, including the cold. This is not the case: Antibiotics work only against bacteria. Another myth is that all antibiotics kill bacteria. In fact, most antibiotics are bacteriostatic: They only keep bacteria from reproducing, giving our immune systems time to do the killing themselves. Some antibiotics, however, are bacteriocidal, which means they directly kill bacteria.

I often hear it said that people can become resistant to antibiotics. In fact, people themselves do not become resistant to antibiotics; it's the bacterial populations inside of our bodies that become resistant. The caution is not that you will become resistant, but that you can become a breeding ground for resistant species of bacteria. Another myth is that antibiotics weaken the immune system. This is not true. They do not have any effect on the immune system. The immune system, in most cases, still has to fight off the infection. Antibiotics just give the immune system a chance to do so.

Some people believe that if an antibiotic has not worked in a specific individual previously, that antibiotic won't work in the future. That is not necessarily true. The effectiveness of any particular antibiotic is specific to the infection—the strain and the species of bacteria—not the person.

One thing about antibiotics that is not a myth is that they should not be overused: Overuse of antibiotics increases resistance. Therefore, it is important to find alternatives to antibiotics. In other words, it's important to find ways to minimize infections rather than relying on an antibiotic whenever you need to. Some alternatives are true and effective. But there are a lot that are myths.

Hand washing is the most effective way to prevent getting an infection.

One common myth that is offered as an alternative to treating a bacterial infection with antibiotics is supplements or products that boost the immune system. If you are healthy, well-nourished, and not sick, your immune system will be functioning optimally. There is no way to boost it or increase its activity beyond its already optimal functioning. Only if there is something inhibiting or interfering with the activity of the immune system can you take steps to restore the immune system to its normal functional state.

One product that has been around for years as an alternative to antibiotics is called colloidal silver. This is actually the element silver, in a suspension that you are meant to drink. The claim is that silver has antibacterial activity. Silver is used externally to sterilize, for example, medical equipment—but it is not meant to be taken internally.

One alternative, however, is genuine: honey. Honey, while not an antibiotic when taken internally, does have antiseptic properties when used externally. Studies show that using honey as an antiseptic in a wound works quite well—almost as well as pharmaceutical creams that are designed specifically for that purpose.

Hand washing is the single most effective behavior to prevent getting an infection, such as the cold, flu, or more serious bacterial infections. This is especially true if you are exposed to people who you know to be sick. Health-care workers, for example, especially need to wash their hands. What about antibacterial soaps? These are very common on the market these days. What makes a soap antibacterial is that it contains a chemical, the most common one being triclosan, that has an antibacterial effect. But in 2007, a systematic review concluded that antibacterial soaps containing triclosan are not more effective than regular soap. However, there are some studies that show that it may be more effective if it is combined with other antibacterial agents. The jury is still out on whether we can develop an antibacterial soap that has advantages.

We do need to take reasonable measures to stay hygienic and free from infection. Knowing when to use an antibiotic is also very helpful, as is knowing when not to use an antibiotic. While basic hygiene is good, scientists are actually considering the possibility that our modern society may in fact be too hygienic for our own good. A little exposure to germs may not be a bad thing. ■

Suggested Reading

Brown, *Penicillin Man*.

Scientific American Readers, *Infectious Disease.*

Questions to Consider

1. How often, in what circumstances, and with what kind of products should you wash your hands?

2. Is it possible to have too much hygiene? Why or why not?

3. When is it appropriate to use antibiotics?

Vague Symptoms and Fuzzy Diagnoses
Lecture 13

We begin to get a little suspicious when the more we investigate a questionable diagnosis or a vague diagnosis, the less we seem to understand about the pathophysiology. If the people who are promoting the notion of this problematic diagnosis use what we call special pleading, they explain away all the lack of evidence that we would predict should be there if the disease had a specific biological cause, for example.

This lecture is about diagnoses: the labels we attach to the signs and symptoms that people have. The core myth of this lecture is that all diagnoses are the same and equally valid. The truth is that we arrive at these labels in very different ways. For example, there are some diagnoses that we would call a disease, like diabetes. It's a pathological disorder we can identify. A disorder does not necessarily have a pathological change in any cells, but there is some problem with functioning that is identifiable; an example of this is attention deficit hyperactivity disorder. There are also syndromes, which are lists of signs and symptoms that tend to occur together. A clinical syndrome may not be one specific disease. ALS is actually a clinical syndrome, not a specific diagnosis.

It also is important to recognize that there are categories of diseases. Sometimes we may identify that a disease belongs to a certain category—for example, inflammatory versus nutritional versus degenerative—even though we can't get more specific than that. This all relates to how doctors make diagnoses in the first place. What do they mean? How do we understand and use them in medical practice? Ultimately, the goal of understanding the illness is to come up with treatments that are effective.

We don't want to wait until we understand every last thing about a disease or a disorder before we treat it. There are multiple ways to treat a syndrome or a disorder before we completely understand its cause. People often think only in terms of curing a disease, but mostly physicians simply treat various aspects of a disease. For example, we may reduce the risk of developing a disease. We may slow its progression or even stop it from progressing. We may reverse some of the damage or disability that has resulted from the disease. We may alleviate symptoms and improve quality of life, prevent complications of the disease, or prolong survival with it. None of those things would be considered a cure, but they are all tremendously useful.

There are multiple ways to treat a syndrome or a disorder before we completely understand its cause.

Let's continue to examine how doctors make diagnoses. There are different types of diagnoses: There are clinical diagnoses, which are based on having a certain set of signs and symptoms. (Symptoms are something the patient experiences; a sign is something you see when you examine a patient.) There also are laboratory methods, like blood tests and X-rays, of making or confirming a diagnosis. And when a diagnosis is made entirely by biopsy, we call that a pathological diagnosis.

Doctors also sometimes make what we call a diagnosis of exclusion. You have an appropriate clinical syndrome, and we rule out everything else that can cause that syndrome. What you're left with is the diagnosis of exclusion—something we know can cause those symptoms, even though we may not have any laboratory test to confirm it.

There are many problematic diagnoses, however, that are out there. They are less clearly established, more ambiguous, and more controversial. What are some of the warning signs of these problematic diagnoses? They tend to be a clinical syndrome, not something that is tied to a specific laboratory finding. They tend to have common, nonspecific symptoms, such as pain and fatigue. Problematic diagnoses also tend to be highly variable in their presentation. The symptoms and signs that get attached to that diagnosis don't suggest one cohesive, coherent underlying cause.

Another problem is diagnosis creep. Once you have a label—a questionable label based on nonspecific symptoms without anything very objective to verify it—it tends to apply to an ever-expanding list of presentations, with a broader and broader scope. In addition, there's diagnosis expansion, which means applying the diagnosis to milder and milder versions.

Treating these problematic illnesses—when we have only a vague syndrome without anything specific to hang our hat on—is also, of course, problematic. They tend to be resistant to specific biological interventions and to benefit only temporarily from treatments that are likely to have a placebo effect.

I think we've covered a lot of information about what doctors think about when they're making a diagnosis. There are a lot of pitfalls and it can often be very tricky to make an adequate diagnosis. The approach that we often take is to look for things that we know how to diagnose and how to treat. If we make a diagnosis, then we treat based on the diagnosis that we make. We find any contributing factors and essentially treat what we find.

But sometimes we rule out all of the known pathological contributors or causes of a disease. We're left with a syndrome of symptoms without a clear biological cause, but we have ruled out anything serious or treatable. In that case, it's most effective to then shift our emphasis to treating the patient to improve their quality of life. That is very important and should not be neglected. We shouldn't get distracted from treating quality of life because of a search for a diagnosis that may not be there or just for the false comfort of having a label to attach to symptoms. ■

Suggested Reading

Barbour, *Lyme Disease*.

Lipson, "Fake Diseases, False Compassion."

Questions to Consider

1. Do you think chronic fatigue syndrome is a genuine disorder?

2. What makes one diagnosis useful and another problematic?

3. Do you think we overmedicalize everyday symptoms?

Herbalism and Herbal Medicines

Lecture 14

The history of herbalism goes back farther than the human species itself. Many animals will chew on different plants when they have symptoms or infections.

Herbalism is the appealing notion of using plants to strengthen our health and treat medical symptoms, but what does science tell us about modern herbalism? You may be surprised to learn that modern herbalism is scientific. In fact, the core myth of this lecture is that there's something fundamentally different between herbalism and modern pharmacology. They are both part of the same science, which is identifying useful substances that have some biochemical effect in the body that can be exploited. Herbalism, or phytotherapy, simply restricts its range to plant-derived substances.

Pharmacognosy is the study of drugs or drug substances of natural origin as well as the search for new drugs from natural sources. A lot of modern pharmacology derives from the study of the health effects of plants or things that are derived from plants. Many modern drugs, for example, themselves are plant components. Modern pharmacology, which includes studying plants and other natural sources, has a specific definition. Essentially, a pharmacological agent or drug is any substance that has a biochemical effect on the body, including the microbes in the body, beyond its purely nutritional value.

In short, herbs are drugs. But in some countries, like the United States, herbs are marketed as if they were supplements. They are regulated as if they were food or vitamins. Herbs often have many active ingredients. The justification for this is the notion of synergy: that different substances individually might not have much of an effect but when taken together have a useful clinical effect. There can be synergistic effects in herbs; however, we can't assume that that's the case. We need to base any such determination on actual scientific evidence.

It also needs to be noted that chemical substances in plants or herbs—which are taken for their pharmacological activity—have the same range of side effects and toxicities that other drugs do. We should not fall into the false dichotomy of thinking that herbs are fundamentally different from drugs.

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Because herbal supplements are not regulated, their purity and dosing are not guaranteed.

What about dosing? One of the primary advantages to the drug development process is that we isolate a specific chemical. We can then deliver it in amounts that are very precisely measured. When herbs are studied, it turns out that many have tremendous variations in the amount of active ingredients they contain. Part of the reason for this is the variation from plant to plant. It's very hard to control for the amount of active ingredients just by using a certain amount of the plant itself.

One thing we've learned in the last hundred years or so of doing scientific experiments for medical treatments is that, for every hundred or so treatments that look very promising in the laboratory, very few of them actually make it all the way through clinical research and are shown to be safe and effective in people. Sometimes there are in vitro or preclinical data that suggest a potential role for an herb, but it isn't appropriate to extrapolate from these preclinical studies to clinical claims.

Another area of concern is that recently it's come to light that many herbal products are contaminated. Some of them contain other herbs that are not on the label. A 2009 study of herbal remedies that were purchased over the Internet found that about 20% of them were contaminated with heavy metals above safe limits. This included lead, mercury, and arsenic—some as much as 10,000 times the safe limits. This raises the notion that we need better quality control.

We should not fall into the false dichotomy of thinking that herbs are fundamentally different from drugs.

Plants are legitimate sources of safe and effective drugs. We have explored them to discover many useful chemicals. Much of the low-hanging fruit has already been picked, but there is still a lot of research that can be done. There may be very effective drugs, treatments, and even herbal preparations out there waiting to be discovered by careful research. But herbal remedies today are poorly regulated. Herbs need to be recognized as the drugs they are and regulated appropriately so that they can be used safely and effectively. ■

Suggested Reading

ICON Group International, *Pharmacognosy*.

Samuelsson and Bohlin, *Drugs of Natural Origin.*

Questions to Consider

1. Should herbs be regulated as food supplements or as drugs?

2. What does the scientific evidence say about the most popular herbal remedies?

Homeopathy—One Giant Myth

Lecture 15

> **Homeopathy ... is even more popular in Europe than in the United States. In Europe, it is a $1.4 billion a year market, according to *Business Week*. It is popular with the British Royal family and is currently supported by the NHS [National Health Service].**

There are a lot of misconceptions about what homeopathy is. Many people think that homeopathy means herbal medicine or natural medicine, but this is not true. Homeopathy, in fact, is a 200-year-old philosophy-based system. It's based on the notion of vitalism, the idea that living creatures have an essence or vital force that animates them. Homeopathy survives today due to cultural inertia and despite a complete lack of scientific evidence.

Homeopathy was developed by Christian Friedrich Samuel Hahnemann (1755–1843), a German medical doctor. In the 1790s, Hahnemann came up with several laws that govern the actions of homeopathic remedies. The first law of homeopathy is called the law of similars. He claimed to discover this principle when he noted that the cinchona bark, which is used to treat malaria, caused him to have symptoms very similar to those of malaria. He therefore generalized this one observation to this law, which became one of the cornerstones of homeopathy.

Hahnemann's next law is the law of infinitesimals. He believed that substances transferred their essence to water in which they were diluted. The greater the dilution, the greater this transference of essence was. The law of the individual remedy states that each person's totality of symptoms has a single underlying cause. Therefore, homeopathic remedies are intended to treat all of those symptoms at once with a single remedy. Homeopathic remedies also include the notion of potentiation. Between each dilution, homeopathic remedies are potentiated by succussing them. That means shaking them in a certain way; this is more of a ritual than science or chemistry.

What does the clinical evidence show? There have actually been hundreds of clinical studies of homeopathic remedies. After reviewing all of the evidence for homeopathy, the scientific community has come to the conclusion that there is no evidence to support homeopathy for any indication. Also, homeopathic remedies are no different than placebos.

The scientific community has come to the conclusion that there is no evidence to support homeopathy for any indication.

There are many homeopathic products on the market, however. They are marketed because of loose regulations without evidence for either safety or effectiveness. Homeopathic remedies are generally safe, because they're usually just water. There is no active ingredient, so they don't really have the potential to cause direct harm. But this is not universally true of homeopathic remedies. Some homeopathic products cheat the system by including measurable levels of active ingredients but using the homeopathic label to skirt regulations.

One example is Zicam. This is a product that was marketed as homeopathic. Some preparations of it have measureable and meaningful amounts of zinc oxide, which is shown to treat and reduce the symptoms of a cold. However, zinc oxide is also known to cause anosmia, a sometimes permanent loss of the ability to smell. Several people who were using Zicam had permanent anosmia as a side effect. That caused regulatory agencies to take a second look at it and to temporarily suspend it from the market.

One justification for the ultradilutions of homeopathic remedies that's often given is the analogy to vaccines or allergy shots. This is a myth and not an apt analogy. A vaccine contains a measurable, if small, amount of antigen meant to stimulate the immune system. Allergy shots give a small amount of a substance to which one is allergic in order to provoke the immune system to make blocking antibodies. They make antibodies to the substance to help prevent an allergic reaction. In order for allergy shots to work, you have to give a small dose and then build it up to increasingly larger doses. Eventually, you're giving a fairly significant dose in order to provoke a sufficient immune response. Therefore, there is no analogy whatsoever to a preparation that has no measurable amount of anything in it.

Testimonials and anecdotes tend to support what people want to believe. There are also placebo effects, which can make anything seem to work. There's also often a failure to recognize the harm that could be done with these types of interventions. I mentioned that homeopathy mostly is a completely inactive substance; it's just water without any active ingredient. Some people will say if it does nothing, how could it possibly do any harm? The harm often comes in preventing effective treatment. There are many cases of harm occurring to people relying upon homeopathic remedies who could have easily been treated with modern medicine.

There's a broader intellectual conflict that's represented by homeopathy. It's between science-based medicine—what we recognize today as the modern scientific approach to biology, healing, and disease—and what we would now think of as magical thinking. Over the last 200 years, the scientific approach has clearly won out. It has produced all of modern medicine, whereas homeopathy is stuck in the 200-year-old ideas of its founder. Completely inert treatment may have actually been an advantage to what was passing for standard medicine 200 years ago. But today, science-based medicine has brought us a host of effective treatments. ■

Suggested Reading

Barrett, "Homeopathy."

Ernst, *Homeopathy*.

House of Commons Science and Technology Committee, "Evidence Check 2."

Science-Based Medicine (blog), "Homeopathy."

Questions to Consider

1. Do you know what the central claims of homeopathy really are?

2. Why has homeopathy survived as long as it has, despite a complete lack of scientific validation?

Facts about Toxins and Myths about Detox

Lecture 16

Have you ever considered having your colon cleansed? How about ear candling or having the toxins leached out of the bottom of your feet or squeezed out of your muscles? Are the fears over toxins and their treatments real medicine, or just more marketing hype? You can probably guess where I'm going to go with this one.

This lecture is about toxins in the environment; fears of these toxins; and alleged treatments for toxins, such as detoxification or "detox." Technically, a toxin is a poison that is produced by a living organism, such as a protein. Colloquially, it refers to any substance that is poisonous to a living organism. In reality, everything can be a toxin or can be completely safe, depending on the dose. Even water and oxygen can be toxic at high enough doses.

Our bodies have mechanisms for dealing with toxins. One of the most significant is the liver, which produces enzymes to metabolize toxins in order to neutralize them. Other organs are also involved: The kidneys continuously filter the blood, removing harmful waste products or toxins and then excreting them in the urine. The skin also excretes toxins through sweat.

So are there any real toxins that you need to worry about? Yes, toxicity is a real potential health hazard. For example, there are risks of overdose. One of the most common overdoses is multivitamins or supplements, particularly of iron in children. Overdoses can happen with just about any prescription or recreational drug. Even common ones like alcohol can cause toxicity due to excessive use.

Food is another source of toxins or potentially harmful chemicals. For example, pathogenic bacteria can contaminate food. There may also be contaminants in food production, and fresh fruits and vegetables may contain small amounts of pesticides. Other environmental toxins include lead and cigarette smoke.

Yes, there are toxins in our environment. But does this mean that the claims made for detox treatments are legitimate, that they can remove toxins from the body? There is no evidence for the need for routine or nonspecific detox. This is just marketing hype, a marketing strategy playing off fears of toxins in the environment. In case of genuine toxicity or genuine overdose, targeted medical diagnosis and treatment is necessary, not some nonspecific detox product.

First- and secondhand tobacco smoke are common sources of toxins in our environment.

Let's look now at some of the popular detox treatments that don't have medical legitimacy. For example, there is the colon cleanse—cleaning toxins out of your colon or out of intestinal walls. One version of this is the coffee enema, which claims to clean out toxins that are collecting and gunking up the intestinal wall. There is no evidence for toxins or anything clogging up the walls of the intestines. The intestines continuously move waste through, and everything eventually comes out. There is no theoretical reason for coffee enemas or other colon cleanses. This is also not a risk-free procedure. Enemas carry the small but real risk of perforating the colon.

Another entirely different type of treatment with the same claims of detoxification is rolfing. This is a deep, often painful, muscle massage. The idea is that by squeezing the muscles very strenuously, you will squeeze out the toxins into the blood, and then they'll be removed by the liver and kidneys. There's no proven health benefit to rolfing, and it actually contains a small risk of nerve or muscle damage.

Next we have ear candling. The procedure is to put a wax candle in your ear with your head down on its side. The claim is that burning this candle in your ear will draw out the wax, and toxins, from inside your ear. This has been studied in several different ways. First of all, there's no negative pressure created, no sucking action. In addition, the wax that collects on the plate at the base of the candle has been shown to be entirely composed of wax from the candle itself; it's not earwax. The black sooty material that proponents often say is the toxins drawn out of the body is nothing more than ash from the wick of the candle. The procedure also carries the risk of burning or damaging the eardrum.

There are also many herbal or diet detox products—too many to name. This is a very common type of supplement on the market today. These are usually harmless mixes of vitamins, herbs, or some food regimen. They are alleged to give your body a break from toxins or to augment your liver and kidneys' ability to remove toxins from your body. There is no basic science or any clinical evidence to support any of these claims.

Ultimately, dealing with the notions of toxins and human health is about balance. Yes, there are toxins, and you do need to be reasonably aware of them. However, it is easy to spread unreasonable fears that are not based in science. Sometimes these unreasonable fears are used to sell products that make nonspecific claims not backed by science. The bottom line is not to get scammed by fear. Beware of products that make claims that have not been verified by science. Let's end with a quote from some colleagues of mine, Simon Singh and Edzard Ernst, who said about detox products, "The only substance that is being removed from a patient is usually money." ■

Suggested Reading

Australian Skeptics, "Debunking the Detox Myth."

Karasov and Martinez del Rio, *Physiological Ecology*.

Novella, "The Detox Scam."

Questions to Consider

1. What are the most common toxins to be aware of?

2. Which detox products, if any, are legitimate? Why?

Myths about Acupuncture's Past and Benefits

Lecture 17

The notion that acupuncture is ancient has led to what some call the argument from antiquity. If the idea's been around for thousands of years, then it must have some merit. But, on closer inspection, this is simply not true.

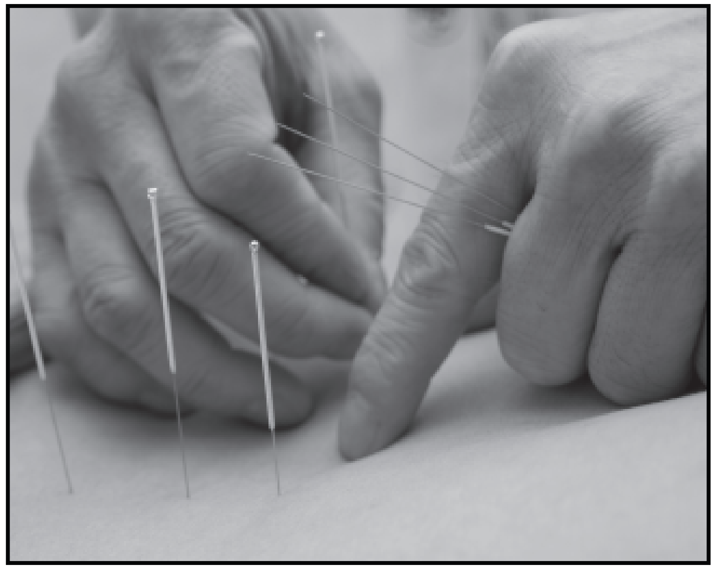
Acupuncture is perhaps the most misunderstood of the so-called alternative treatments. The history of acupuncture is different from what many people might suppose. The first myth of the acupuncture history that I'd like to debunk is the notion that it is uniquely Eastern. In fact, the ideas behind acupuncture were common to most ancient cultures, East and West.

A concept that you may think of as Western—and that is also common among many cultures—is the use of bloodletting. There are significant historical records that show that traditional acupuncture points were very similar to the bloodletting or lancing locations that were being used in the West. Chinese acupuncturists were largely peasant healers who practiced minor surgery, bloodletting, and needling. All of these practices were mixed together in one cohesive system.

But in China in the 1930s, there was a period of acupuncture reform. Chinese pediatrician Cheng Dan'an moved the traditional acupuncture points from over veins to over nerves. He distanced the practice of acupuncture from bloodletting; he changed the concept to using fine needles to affect nerve function. This is the modern concept of acupuncture, which is taught in the West.

The modern practice of acupuncture involves sticking a very thin needle into one of thousands of acupuncture points to a certain depth. The needle is then rotated in order to elicit what's called the *de qi*, which is a vibrational sensation. It's that sensation that is thought to represent the unblocking of the flow of the vitalistic energy.

There are many different claims made for the modern incarnation of acupuncture. The most common claim is pain relief, but it's also used to treat nausea, addiction, and back pain. There is also something called medical acupuncture that is used to treat diseases, including serious illnesses such as cancer, and to enhance the chances of becoming pregnant. There are also claims made for acupuncture anesthesia, the ability to perform invasive surgery with nothing but acupuncture for pain relief.



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The perceived benefits of acupuncture may actually be placebo effects.

Some scientists have sought a modern, physiologically based explanation for how acupuncture may be producing the effects that are attributed to it. These, so far, are mostly speculation. There have also been published studies looking at other biochemical effects. In 2010, a study was published in *Nature Neuroscience* that found that needling with an acupuncture needle caused the local release of a chemical known as adenosine. In response to this, local pain and inflammation decreased. But there are significant limitations to this study: It was done in mice, and there were no controls in this study. All we can really say, based upon this study, is that there is a local tissue response to minor trauma. This then inhibits the inflammation and pain that results from that trauma—not surprising when you really think about it. But, the specific mechanism that was identified may lead in the future to treatments that will help address both pain and inflammation.

What about the clinical research for acupuncture? Acupuncture is one of the most studied of the alternative modalities. The main challenge in designing acupuncture trials has been properly blinding both the acupuncturist and the subject. It's hard not to know if a needle is being stuck into some part of your body or if you are doing the sticking. However, this technology has evolved quite nicely. There are several kinds of controls that are used in high quality research. These controls include sham acupuncture and placebo acupuncture.

The results of this research are very informative. Sham acupuncture studies have shown that it doesn't seem to matter where the acupuncture needles are placed. Placebo acupuncture shows that it doesn't matter whether you stick the needles at all—the needles don't have to be stuck through the skin in order to get the same effect. An example of this is a 2009 large back pain study published in the *Archives of Internal Medicine*. That study compared individualized acupuncture, cookbook acupuncture, and placebo acupuncture. All 3 groups had exactly the same response. It doesn't matter where you stick the needles, and it doesn't matter whether you stick the needles.

Acupuncture is one of the most studied of the alternative modalities.

What does this mean? How do we interpret this research? It means that the perceived benefits come from the other aspects of acupuncture, not sticking needles into specific locations. Some of these effects may be placebo effects—the expectation of benefit, the desire for benefit. They may also be nonspecific effects from the ritual that surrounds acupuncture. While receiving acupuncture, you may be lying down on a table for 30 to 60 minutes. There may be pleasant music playing in the background. The acupuncturist may palpate the acupuncture points, maybe even providing a little massage. There's the positive interaction with a therapeutic person. All of these contribute to having a perceived benefit, especially for subjective symptoms like pain.

There have been many systematic reviews of clinical trials for acupuncture. Reviews of acupuncture for back pain, in vitro fertilization, chemotherapy side effects, and addiction have all been completely negative. They conclude that either it doesn't work at all or for some indications. There's no evidence to show that it works, but there hasn't been enough research to completely close the door. The one exception to this is nausea. There is weak evidence for a mild effect in treating nausea. But, again, this is preliminary evidence that is not yet definitive. ■

Suggested Reading

Eckman, *In the Footsteps of the Yellow Emperor*.

Kavoussi, "Astrology with Needles."

Science-Based Medicine (blog), Archive for the "Acupuncture" Category.

Taub, "Acupuncture."

Questions to Consider

1. How have the concept and practice of acupuncture changed over the centuries?

2. Can modern science provide a plausible mechanism for the alleged effects of acupuncture?

3. What does the clinical evidence tell us about the effectiveness of acupuncture?

Myths about Magnets, Microwaves, Cell Phones
Lecture 18

For centuries, magnets have fascinated people. This has contributed to widespread use in many dubious devices and also fraudulent health claims. At the same time, magnetism and electromagnetism are legitimate, real forces of nature that are biologically effective and are used in legitimate scientific research.

Electromagnetism is a fundamental force of nature. In essence, we are all electromagnetic creatures: The processes and chemical reactions that all living cells use to carry out the processes of life are electromagnetic at their core. Therefore, it is no wonder that the connection between healing and magnetism is as old as knowledge of magnets themselves. But this has also led to many myths about healing and magnetism.

Magnetic fields are involved with biology in that cells use electrical currents as part of their basic functions. The nervous system is essentially an electrical system. It is true that focused, powerful, dynamic magnetic fields can alter brain function. In fact, we use a device called a transcranial magnetic stimulation with diagnostic and therapeutic effects. For example, this device uses a dynamic magnet—which uses an alternating magnetic field—at a very specific frequency or different frequencies to turn on or off certain parts of the brain.

This is an important new device in neuroscience research because activating or inhibiting parts of the brain allows us to figure out what those parts of the brain do. It's important to recognize that medical devices that use electromagnetic fields are largely dynamic magnets. They are not only fairly powerful, but they also involve a rapidly alternating polarity or strength with a certain frequency. Most of the magnetic devices on the market, however, are static magnetic fields. Static magnetic fields do not cause any change in conduction. They do not induce an electrical current and are essentially biologically inert.

What are the proposed mechanisms for typical magnetic healing devices that are on the market? One claim is that these magnetic fields will attract the iron in your blood. But this is not plausible: The form of iron in your hemoglobin is not ferromagnetic; it does not respond to a magnetic field. Other claims include increase in immune activity or decrease in immune activity, to reduce inflammation. Neither of these has been supported by research.

Using cell phones for a short period of time, less than 10 to 15 years, has not demonstrated increased association with brain tumors or other health risks.

It's interesting to note, to put this into perspective, that we routinely expose patients to very powerful magnetic fields. Magnetic resonance imaging (MRI) is a technology we use to look inside the brain or other parts of the body. Patients go inside a very large and powerful magnet, somewhere between 2 to 4 Tesla. This is literally millions of times more powerful than the magnetic devices you can buy at the drugstore. Over years of using MRI scans and studying them quite extensively, we have found that putting someone in a powerful static magnetic field doesn't have any biological effects beyond the ones that we're exploiting to create the images.

What about negative biological effects of electromagnetism? In the 1980s, several studies suggested a possible link between power lines and the electromagnetic fields that they generate and leukemia. Power lines do generate magnetic fields. However, in the wake of these preliminary studies, larger epidemiological studies failed to show any correlation. The concerns were essentially laid to rest by larger, better studies, but with this type of evidence, a small correlation can never be completely ruled out.

What about microwaves; do they pose a threat to us or the food that we eat? Microwaves are simply a frequency of electromagnetic waves that are in the microwave frequency. While microwaves do alter the chemical composition of food, they do so in a way that's really no different from just cooking food, so there are no specific concerns about that.

But there is the concern about radiation leakage from the microwaves themselves. If microwaves are properly constructed, any radiation leakage is insignificant and poses no health risk. The only risk would be from having a faulty microwave oven: one that was not well constructed—which regulations should prevent from happening—or one that is failing in some way. However, it is true that you shouldn't stand immediately next to a microwave while it's operating. Doing that very briefly is fine. But because there may be a small amount of radiation close to the microwave, you shouldn't stand next to it for long periods of time.

Cell phones present another source of radiation, an increasingly ubiquitous form of exposure to nonionizing radiation. After all, we often hold cell phones close to our heads. Is it possible that our brains are getting exposed to this nonionizing radiation and this may cause an increased risk of cancer or other health problems?

Microwaves do not alter the chemical composition of food any more than cooking does.

The plausibility of this claim is actually quite low in that the electromagnetic fields produced by cell phones are very weak. Also, it is nonionizing radiation, which has a very weak effect on biological tissue. Ionizing radiation, like the kind you would get from radioactivity, does cause DNA and other types of cell damage. This question of whether there any health risks from cell phones has been studied for years. At present, what we can say is that there is no clear-cut risk from using cell phones. Using cell phones for a short period of time, less than 10 to 15 years, has not demonstrated increased association with brain tumors or other health risks.

However, the literature is still a bit mixed and not definitive for long-term exposure: that greater than 15 years or in children who begin to have exposure to cell phones at a young age. There still may be a reason for a small amount of caution there. ■

Suggested Reading

Flamm, "Magnet Therapy."

Mesmer, *Mesmerism*.

Questions to Consider

1. What effects do magnets have on the human body?

2. Why do you think magnets are such a common target for dubious remedies?

All about Hypnosis

Lecture 19

Have you ever been daydreaming while driving in the car and arrived at your location without remembering how you got there? ... Much of what happens in the brain while you're daydreaming—not paying attention to external stimuli, although still being able to process them enough to drive to your destination while imagining being somewhere else or in another situation—is very similar to what happens during hypnosis.

Like most people, you probably know hypnosis from what you've seen on stage or on television. An ordinary person is put into a trance-like state and then starts walking around clucking like a chicken on cue because they were hypnotized to do so. What is hypnosis really? The first myth about hypnosis I'd like to put to rest is that it's a trance-like state. In fact, it isn't an altered state of consciousness or unique state of consciousness. It's actually a state of heightened alertness.

How do you hypnotize someone? It really just has to do with how you interact with the person. For example, the process might involve making someone more suggestible and encouraging them to relax, encouraging them to focus on the person who's doing the hypnotizing, giving them small suggestions to reinforce their attention, and encouraging visualization. Stage hypnosis is different from medical hypnosis; the latter is the topic for the rest of this lecture.

There is a very serious neuroscience surrounding what happens in the brain when people are being hypnotized. These effects fall under 4 broad categories: increased suggestibility; heightened imagination; a lack of attention to sensory information, even a sense of detachment from one's self or environment; and a decrease in executive function, which is the highest order of thinking.

Can hypnosis be used for beneficial medical or psychological effects? Let's turn first to memory. Can we hypnotize people who are having trouble remembering details and get them to recall an event in vivid detail, as is often portrayed on television? It turns out that we cannot. In fact, if anything, the opposite is true. Hypnosis is a condition in which a person is in a high state of imagination and can be highly suggestible. Therefore, patients are likely to make up details at the slightest suggestion.

But there are indeed some legitimate uses of hypnosis. Hypnoanesthesia is the use of hypnosis prior to a surgical or medical procedure to reduce the need for sedating medication. This usually involves self-hypnosis: The person uses techniques like meditation and imagery. This self-hypnosis has been shown to minimize, but not eliminate, the need for sedation. Local anesthesia is often still used. Very closely related to hypnoanesthesia is hypnoanalgesia. Reviews of evidence indicate that hypnoanalgesia is in fact useful for decreasing chronic pain.

Hypnoanesthesia is the use of hypnosis prior to a surgical or medical procedure to reduce the need for sedating medication.

Cognitive hypnotherapy uses hypnosis to treat depression, sleep disorders, chronic pain, and post-traumatic stress disorder. The techniques used involve meditation, cognitive therapy, and self-hypnosis. Cognitive therapy is a separate part of behavioral treatment or talk therapy for all of these conditions, and it has independently been shown to be effective. When hypnosis, mainly involving meditation, is combined with cognitive therapy, it's shown to have significant advantages.

I've mentioned several times the notion of meditation as a form of self-hypnosis. Meditation is not hypnosis exactly, but it is closely related. It is a self-induced state of relaxation. This relaxation may also involve active thinking, self-reflection, or an attempt to achieve a state of what is called mental silence—essentially thinking about nothing.

There are two basic types of meditation and various uses to which they are put. One is called concentration meditation. In concentration meditation, practitioners focus on an object or idea as an anchor to focus their thoughts. In mindfulness meditation, the awareness is not focused on one thing but is distributed as broadly as possible. Their awareness is diffused to everything in the environment, which puts them in a state similar to mental silence.

There is evidence to support medical uses for these types of meditation for pain, blood pressure, stress management, and muscle relaxation. So far, though, there is no evidence to support meditation for psychological conditions like attention deficit and hyperactivity disorder or anxiety. ■

Suggested Reading

Jamieson, *Hypnosis and Conscious States*.

Lynn and Kirsch, *Essentials of Clinical Hypnosis.*

Questions to Consider

1. Is hypnotism real? Do scientists know what is happening in the brain when someone is "hypnotized"?

2. Does hypnosis have legitimate clinical uses?

Myths about Coma and Consciousness

Lecture 20

There is a famous case of a man named Jean-Dominique Bauby, a French journalist, who had a stroke in 1995 at the age of 43. It left him locked in. He could only blink his left eye. However, he dictated the entire book *The Diving Bell and the Butterfly* one letter at a time by blinking.

TV and movies are full of stories in which someone is in a coma and then at some point, maybe even after years, they wake up—largely neurologically intact. The media also loves stories about people awaking from a coma. This all contributes to a lot of confusion about what coma actually is.

Coma is a disorder of consciousness or wakefulness. What are the causes of coma? One is trauma. Damage to enough neurons can impair the brain's ability to generate enough function to be awake. Another cause is diffuse anoxic/ischemic injury, in which something interrupts the blood flow to parts of or all of the brain. This causes enough damage to parts of the brain that you cannot generate consciousness.

A completely different phenomenon that can impair consciousness is a seizure. A seizure is typically a synchronized, abnormal electrical function where brain cells start to fire in unison. This can happen in one part of the brain or can spread throughout the brain. If a seizure occurs in enough of the brain, it can cause a person to be unconscious. Prolonged seizures can even make a person appear to be in a prolonged coma.

One myth about coma that I want to dispel is that coma is a specific brain state—like a switch that is either on or off. In fact, coma is a continuum. Diagnosing coma offers a lot of challenges to the neurologist. The primary problem is that a lot of the neurological exam is based upon a person being awake and being able to follow complex instructions and answer complex questions. That enables us to probe and query the different functions of the different parts of the brain. Another challenge is that consciousness may be intermittent. If you happen to examine a patient when she's asleep or when her consciousness is at a minimum, you may miss the fleeting evidence of that minimal consciousness.

There are a lot of new technologies currently being used or on the horizon. One of these is the functional MRI scan, which measures blood flow to the brain. By that, we can infer which parts of the brain are functioning and how much they're functioning. PET scans also image blood flow or metabolic activity in the brain so that we can infer brain activity.

What about the notion of waking from a coma? When somebody is in a coma, can they wake up? The short answer to that question is it depends. The most significant factor that determines whether someone can wake up is whether the cause of the coma is reversible. With reversible causes of coma, you absolutely can wake up. For example, someone with a toxic or metabolic cause that's inhibiting brain function can wake up as soon as the toxin or the metabolic problem is removed. Trauma has a very poor prognosis because trauma represents actual brain damage. Seizures are a bit of a mixed bag. A seizure in and of itself can cause somebody to be comatose. If the seizure is the primary or sole cause of the coma, then treating the seizure can cause somebody to wake up from a coma. But sometime the seizures were occurring in the first place due to a lot of underlying brain damage, which by itself is causing the coma.

By day 3 of a coma ... we can make a very accurate prediction about the probability of someone having potential to awaken.

How good are we at predicting whether someone has any potential to wake from a coma? There are a few things that we do know: The longer that someone is in a coma, the lower their prognosis or statistical chance that they will wake up. The deeper the coma—in other words, the less brain function that there is—and the older the age of the patient, the worse the prognosis is also. Within 48 hours of someone entering a coma, prognosis is very uncertain. But by day 3 of a coma, using the neurological exam alone or with additional tests, we can make a very accurate prediction about the probability of someone having potential to awaken.

Let's look at some other myths surrounding brain function. What about getting knocked out? This is another TV and movie cliché, where someone is hit on the back of the head, maybe by the butt of a gun. He'll be unconscious for an hour or so and then wake up with nothing more than a serious headache. Does this actually happen? You can knock somebody out by hitting him on the head, but he is unlikely to wake up with no injuries at any time after that. In fact, losing consciousness from a brain injury or from trauma is usually the threshold that will cause some permanent brain damage.

What about amnesia? Another common TV and movie myth is that somebody with a head injury will lose all memories of who she is and what her life has been like up to that point. There's a kernel of truth here in that a head injury, especially one hard enough to cause loss of consciousness, can cause loss of memory. However, it is a complete myth that people will forget who they are from a head injury or any neurological condition. If you have enough brain function to be awake, you know who you are. People who don't remember their name or their identity have a psychiatric condition, not a neurological condition.

Another brain myth that comes up often in the context of coma is the notion that we only use 10% of our brain. Unfortunately, this is a complete myth. We use 100% of our brain. There are many lines of evidence that support this—from anatomical studies to functional studies looking at PET scans, MRI scans, and functional MRI. The entire brain is functioning, and loss of 10% or 20% of the brain is actually correlated with a significant loss of cognitive function.

The brain is the most complex organ in the body—maybe the most complex thing that we're aware of in the universe. Although we don't fully understand brain function or how it generates consciousness, we understand a lot about it. We are getting an increasingly detailed picture of the different parts of the brain: how they function, how they interact together, how they contribute to consciousness, and how damage to different parts of the brain can impair consciousness. ■

Suggested Reading

Bauby, *The Diving Bell and the Butterfly*.

Parker and Parker, *The Official Patient's Sourcebook on Coma*.

Posner et al., *Plum and Posner's Diagnosis of Stupor and Coma.*

Questions to Consider

1. What do we know about the neural correlates of consciousness—how brain function causes our conscious awareness?

2. Can someone really awaken after being in a coma for years?

3. What would you say about the idea that most people use only 10% of their brain function?

What Placebos Can and Cannot Do

Lecture 21

There's also what we call nocebo effects. If these psychological factors or some of them can lead to the false impression that there is a benefit from an inactive treatment, can there also be harm or perceived or measured harm from an inactive treatment? It turns out that there can be.

A placebo is any inactive substance or intervention given as a real treatment. Any perceived response to a medical intervention other than a physiological response to an active treatment can be considered a placebo response. There are many types of placebo effects. One category is psychological effects. These include the desire of the patient to improve, to please the person administering the treatment, and to justify the risk and expense of the treatment. Another powerful psychological effect is confirmation bias. This includes the notion that people tend to notice and remember events that confirm their beliefs, biases, and desires. They will also miss, ignore, or explain away any disconfirming evidence.

There are many other observational artifacts that contribute to placebo effects. An artifact is anything that causes an illusion in observation. One that scientists recognize is regression to the mean: In any system or any symptoms that fluctuate over time, any extreme in this fluctuation is more likely to be followed by a return to the mean, just from pure statistics. There are also observer effects. This is simply the understanding that the act of observing affects behavior and outcomes. For example, subjects in a clinical trial may be more compliant with their treatment when they're being regularly seen by a health-care provider.

There are also many nonspecific effects. That means that there are benefits of variables that are incidental to the treatment itself. For example, if you disrupt your stressful day to undergo a treatment, the treatment may be relaxing in and of itself. There's also psychological benefit from the therapeutic and caring attention of the provider.

What about expectation? There is a common belief that someone needs to have an expectation of benefit from a treatment for there to be a placebo effect. This itself is a myth. However, expectation may enhance or increase the placebo effects that are occurring.

Can there be real benefits to placebos? They are present. There are real benefits to placebos, but we have to put them in context to understand that they are very strictly limited. Placebo effects can cause a genuine reduction in stress from nonspecific and psychological aspects of the treatment. And reduction in stress does reduce risk factors for many real biological disorders like heart disease. Muscle tension also responds to psychological stress. When you're anxious or under a lot of stress, you'll tense up your muscles, which can cause a lot of very real symptoms. Therefore, placebo effects that reduce stress will improve those biological functions. The perception of pain is also highly subjective. Anything that provides improved mood or comfort or the expectation of benefit will improve or decrease this perception of pain.

There are real benefits to placebos, but we have to put them in context to understand that they are very strictly limited.

However, these limited and carefully delineated placebo effects should not be used to argue that placebos can have other effects that are not documented and not plausible. Placebos are not a panacea. In fact, systematic reviews of clinical trials have found no measurable mind over matter or biological placebo effect.

So is there anything beneficial to placebo effects? If so, is there any way to exploit them without deceiving patients and without using treatments that are harmful or contain unnecessary components? First of all, it's important to remember that real and effective medical interventions come with placebo effects. This includes things like a good therapeutic relationship between the treater and the patient, a positive mood and outlook, overall healthful behaviors, and improved compliance with a necessary treatment. However, placebo effects cannot ethically be used to promote pure placebo treatments.

Medical advances can largely be understood as progressively moving away from placebo interventions to biologically active and science-based interventions. But at the same time, ironically, we are trying to understand those aspects of placebo effects that are genuinely helpful. It may seem contradictory: We are using placebos as a very important tool for removing illusions and misdirections from our understanding of what works and what doesn't work. At the same time, we are trying to exploit beneficial aspects of placebo effects to maximize patient healing, reduce symptoms, and improve quality of life. It should be kept in mind that all of the benefits that you can get from placebo effects you will also get from treatments that are science based and actually work. ■

Suggested Reading

Benedetti, *Placebo Effects*.

Price, Finniss, and Benedetti, "A Comprehensive Review of the Placebo Effect."

Questions to Consider

1. What causes placebo effects?

2. Do you think a placebo effect is sufficient to justify a medical intervention?

3. Do physicians commonly prescribe placebos?

Myths about Pregnancy

Lecture 22

It's expected that mothers who are pregnant will gain weight from the pregnancy itself. But how much weight gain is healthy or appropriate? It's not necessary actually for a woman to significantly increase her intake of food. An additional 300 calories per day is the average need of a pregnant woman in order to get all the nutrition that she needs.

Pregnancy is a powerfully emotional event in our lives, for the women who become pregnant, but also for every family member. It's no surprise that when pregnancy comes up, friends and relatives come out of the woodwork with medical advice. But is this advice true, or is much of it myth?

Many beliefs and advice center on how to get pregnant in the first place. The reality of getting pregnant is that timing is everything. The egg and the sperm have to be in the same place at the same time. If you achieve this, fertilization occurs with a 30% success rate.

There are some other variables, however, that people consider to increase the odds of getting pregnant. Does position matter? The bottom line is no, at least not to the probability of getting pregnant. Should you save up sperm? It turns out that maximum sperm counts occur at about 48 hours, so there is no point in saving up beyond a 48-hour time period. There's also no evidence that moving around after sex reduces the chances of conception. You may have heard that if the man sits in a hot tub, that will reduce the chance of conception. That is true; heat does reduce the sperm count slightly.

Once a woman is pregnant, we often want to predict the sex of the child. There are scientific ways to do this. An example is ultrasound, which allows us to determine the sex with about 93% accuracy. But there is a lot of folklore that pretends to be able to determine what the sex of the child will be. For example, carrying low is supposed to indicate a boy, and carrying high is supposed to predict a girl. Actually, how a woman carries is determined by muscle tone and baby position; it has nothing to do with the gender of the fetus.

Another myth is that if the mother is craving sweets, she will have a girl. If she is craving salty foods, she will have a boy. Most pregnant women report that they do have cravings. This is due to altered taste and smell, though there may be other factors like nutritional needs that are not completely clear in the research. However, these cravings bear no relationship to the sex of the child.

What about choosing the sex? Some couples may not want to just predict what sex of child they're going to have; they may want to actually determine whether they have a boy or a girl. There are many folklore beliefs about this. Many of them involve timing, such as whether conception occurs during the day or at night. There are myths about conceiving during a full moon or in a particular position. Other myths involve foods that the mother eats at or around the time of conception. None of these folklore beliefs have any validity in science or medicine.

The evidence for the effects of caffeine is actually quite mixed.

Once a couple has achieved pregnancy, of course, they want to have the healthiest pregnancy possible. This is another source of many beliefs about pregnancy. A healthful diet for the mother is definitely healthy for the baby. Let me go over some nutritional details that are legitimate. You may have heard that fish is brain food and therefore is good for mothers to eat while they're pregnant. This is true, but seafood may also contain mercury. While fish is a good source of certain nutrients during pregnancy, pregnant women should avoid swordfish, shark, and white tuna and should eat no more than 12 ounces of fish per week.

In order to have a healthy pregnancy, there are certain foods that should be avoided. These include unpasteurized milk; soft cheeses such as feta, Brie, or Roquefort unless the label says it's made with pasteurized milk; refrigerated meat spreads or pâtés; and hot dogs and deli meats, unless they are very thoroughly steamed.

What about alcohol? We cannot say, based on the evidence, what a safe level of alcohol is during pregnancy. Therefore, it's best to just avoid it completely.

What about caffeine in pregnancy? The evidence for the effects of caffeine is actually quite mixed. In order to be conservative, it is recommended that pregnant women take less than 200 milligrams of caffeine per day, which is about the amount of caffeine you would get in a 12-ounce coffee.

What about other exposures during pregnancy? Accutane, which is a drug commonly used to treat acne, increases the number of birth defects. Therefore, Accutane should not be used during pregnancy or even while trying to become pregnant. Another thing that women should avoid is nail polish. Nail polish contains phthalates, which are endocrine disruptors and may interfere with certain hormones. What about using a hair dryer? That is safe, as is hair dye.

There have been some concerns raised about pregnant women sitting in front of a computer monitor for hours at a time. There is no evidence or theoretical basis for any health concerns from using computers. However, pregnant women are at higher risk of developing carpal tunnel syndrome. This is because their tissues tend to retain more fluid.

What about air travel—should pregnant women restrict their air travel? The increased exposure to radiation is minimal and of no health concern. But there are legitimate health concerns from long flights. One is to make sure that you keep well hydrated. Also, you should get up and walk around the cabin as often as possible to prevent the occurrence of blood clots in your legs from stasis.

Another genuine risk to pregnancy is smoking. Smoking inputs toxins into the body and can be associated with decreased fetal weight and premature birth. These factors are in turn associated with learning disabilities, increased risk of cerebral palsy, and lifelong problems. ■

Suggested Reading

Bouchez, "Separating Pregnancy Myths and Facts."

Harms and Mayo Clinic, *Mayo Clinic Guide to a Healthy Pregnancy.*

Stone and Eddleman, *The Pregnancy Bible*.

Questions to Consider

1. What are the ways you can predict or determine the sex of a child before it is born?

2. What do you really need to know to have a safe pregnancy?

Medical Myths from around the World

Lecture 23

There are many claims that bee pollen is a superfood, an especially nutritious food. It is a really good food for the bees, and it does contain many useful nutrients. But years of research have not found any specific health benefits for humans.

Taking a broad cultural view might help put beliefs and myths into a broader perspective. Are there some common themes, or is it true that medical myths are specific to individual cultures? We're going to take a look at some medical myths from around the world to try to put this all into a broader perspective.

Let's start with the Korean fan death myth. There is a belief, unique to South Korea, that sleeping with an electric fan running overnight can result in death. Fans in South Korea, in fact, are made with a timer switch so that they will automatically shut themselves off in order to avoid this feared calamity. But is there any plausibility to this belief?

There are several putative causes for what might cause harm or death from sleeping with a running fan. One is hypothermia—that the fan will cause someone to lose too much body heat, their body temperature will drop to dangerous levels, and their heart will stop. Another is that the fan will cause suffocation; it will interfere with the person's ability to breathe.

Is there any real risk from using a fan? In a very hot environment, relying entirely upon a fan may be insufficient. It can lead to hyperthermia and dehydration, which can be dangerous. While fans themselves do not present any risk, relying on a fan under the false assumption that it's cooling a dangerously hot environment may pose some risk.

Now we turn to Africa, where there are many human immunodeficiency virus (HIV) myths. HIV is at epidemic proportions in Africa, with an estimated 22.4 million infected people. Efforts to stem this epidemic rely heavily on the population having accurate information. HIV myths in Africa are therefore especially pernicious and are hampering attempts at controlling this dangerous epidemic.

One horrible myth surrounding HIV in Africa is that it can be cured by having sex with a virgin. This has led to much child rape and the spreading of HIV to children. It also may lead to the false belief that one has been cured, therefore leading to the further spread of HIV.

There's also a belief called HIV denial. This is the denial of scientific evidence establishing that HIV is the cause of the clinical syndrome known as acquired immunodeficiency syndrome (AIDS). This myth is largely based on conspiracy theories—that there is a conspiracy among governments and pharmaceutical companies to sell medications or to decrease unwanted populations.

HIV denial, while somewhat of a worldwide phenomenon, is especially harmful in Africa. Some of these HIV fears were tied to vaccines. There was specifically the myth that HIV was being spread by the West deliberately in the polio vaccine. This crippled vaccine efforts, especially in Nigeria. This decreased compliance with the polio vaccine led to the return of almost epidemic polio in Nigeria, which then spread to other countries, setting back eradication efforts by years, if not decades.

To wrap up our world tour of medical myths, let's look at one that originated entirely in the United States. Many people think that the caduceus is the symbol of the medical profession. The caduceus is essentially a staff with wings at the top that has 2 snakes winding around it. The caduceus is actually the wand of Hermes and has nothing in Greek mythology—or in any other mythology—to do with medicine or the healing arts.

The actual symbol of the medical profession is the staff of Aesculapius. Aesculapius is a Greek god and the son of Apollo. He was the god of medicine. His staff is a staff with no wings and a single snake wrapping around it. That staff is the symbol of medicine and was thought to be a healing staff. The mistake of confusing the caduceus for the staff of Aesculapius was first made by the U.S. Army Medical Corps in the late 19^{th} century. Its spread from there led to medical institutions and hospitals using the caduceus for decades, thinking that it was an appropriate symbol of medicine.

In the middle of the 20th century, the knowledge that the staff of Aesculapius was more appropriate began to take hold. The American Medical Association (AMA) now uses the staff of Aesculapius, and you may notice it painted on the back of ambulances. Even though this story isn't really a health myth, it shows how one authoritative source can be responsible for the spread of misinformation. The spread of this misinformation to other sources like hospitals and the AMA lent it the further appearance of authority. This reinforces the notion that you need to question everything, even if it seems to be coming from a reliable source.

Medical myths from around the world tend to have some similar themes.

Taking a look at these various myths, we see that cultures do vary, but people are fundamentally the same. Medical myths from around the world tend to have some similar themes. These themes include a desire for control, a desire to understand our health, and a desire to have a simple system by which we can understand and improve our health. Another common theme is that people who are ill may become desperate and seek out things to help their problems. I think that by looking at the various myths from around the world, we see that people are the same no matter where you go. ■

Suggested Reading

Brenneman, *Deadly Blessings*.

Epstein, *The Invisible Cure*.

Questions to Consider

1. To what extent are medical myths the same or unique in various cultures?

2. Where in the world is HIV denial most prevalent and pernicious?

3. Why is the caduceus believed to be the symbol of the medical and healing professions?

Roundup—Decluttering Our Mental Closet

Lecture 24

What about the notion that if you die in your dreams, then you will die in real life? ... This is contradicted by reported experiences where people actually do die in their dreams and then live to tell the tale. There is also no theoretical reason why we would expect that dying in one's dream would cause someone to die in reality.

We've taken a look at many medical myths over this course, some serious, others less so—hopefully all interesting. Some myths have a false reliance on authority. Others have a kernel of truth to them that is often misinterpreted or exaggerated. There are also some themes that seem to have been around forever and just won't die; perhaps they appeal to something that's fundamental about human psychology. In this last lecture, we make roundup of many medical myths.

The first myth is that you lose most of your body's heat through your head. This notion is based on a 1970 U.S. Army survival manual claiming that 40% to 45% of body heat is lost from the head. However, this study looked at soldiers who were wearing heavy coats and thermal gear everywhere except for their head. Where does heat loss actually occur? There are several mechanisms of heat loss in your body: One is the evaporation of sweat on your skin. We also radiate body heat away from us.

We lose heat primarily through the entire surface area of our skin, but there are some places on the body where we lose more heat than others. These mainly include those parts of the body that stick out, like our hands, feet, nose, chin, and ears—but not especially our scalp or our heads. The bottom line is that it simply is a myth that you lose most of your heat through your head. You don't even lose more heat through your head than through other parts of the body.

Let's look at another simple myth you may have heard. Does cracking your knuckles cause arthritis or otherwise damage your joints? First, what causes the cracking sound? You are stretching the ligaments that hold your joints together. The joints are filled with fluid called synovial fluid, which expands when you stretch the joint and ligaments. An expanding liquid has less pressure, which causes gases that are dissolved in the synovial fluid to come out and form bubbles. When these large bubbles pop, they form the cracking noise.

There actually has been only one published study looking at the health effects of frequently cracking one's knuckles. The study examined 300 people who were frequent knuckle crackers. It found no increased risk of arthritis, but there was an interesting finding. People who frequently cracked their knuckles did have loose ligaments and grip weakness, probably caused by repeatedly stretching those ligaments.

Rather than seeing it as an unpleasant experience to be told that I am wrong, I've come to appreciate and even enjoy having my own myths corrected.

Here's another quick one: Does hair continue to grow after we die? The answer to this is a simple no. Neither hair nor nails continue to grow after we die. This observation may stem from the fact that after death the skin becomes desiccated, or dehydrated. The skin retracts, giving the false impression of the hair or nails being more prominent.

It may interest you, or perhaps concern you, to learn that even physicians harbor myths. While medical school makes an effort to eliminate any lingering myths from physicians' thinking, this is not a 100% effective process. Even physicians in practice may still have lingering myths that they simply have not had illuminated during their education or careers.

A recent survey of pediatricians, for example, asked many questions about pediatric medicine, focusing on those beliefs known to be common myths. It turns out that 2% to 10% of pediatricians surveyed still believed many false things. Here are some examples: Some pediatricians believe that ice baths can be used to treat a high fever. In fact, you shouldn't give somebody an ice bath to treat a high fever; it's not necessary or safe. Some believe that chicken pox is not contagious before the rash appears. This is also false.

Is it safe to put infants to sleep on their side? It is, though 32% of pediatricians still harbored an older false belief that it wasn't safe to do so. Small percentages of pediatricians think that drinking milk can cause an increase in phlegm, which is not true. Twelve percent still believe in the Mozart effect—the notion that listening to Mozart will make babies smarter—though that has been entirely debunked.

Having our false beliefs challenged is often not a pleasant experience. I understand that I have popped a lot of balloons in the course of these lectures. Perhaps I've even challenged some beliefs that were comforting and that you were relying on for a sense of control. I long ago accepted the fact that my head is filled with misinformation; that's an inevitable consequence of living in our information society. We are constantly surrounded by information, and much of it is not true.

Therefore I have tried to flip my relationship with the notion that I harbor myths and misinformation. Rather than seeing it as an unpleasant experience to be told that I am wrong, I've come to appreciate and even enjoy having my own myths corrected. It is an empowering experience to have this intellectual clutter removed from our mental closet, as it were.

I don't want you to treat me as a definitive authority. I'm just one physician trying to understand the evidence and the literature as I see it. I hope that I have given you a lot to think about and challenged many of your beliefs. Most of all, I hope that I have taught you that you can't assume that what you've always heard must be true simply because many other people believe it and spread it around. You should challenge all of your beliefs. Whenever possible, try to rely on a consensus of authority or, even better, primary sources to verify what you think you know to be true. ■

Suggested Reading

Barrett, "Questionable Cancer Therapies."

Jenicek and Hitchcock, *Evidence-Based Practice*.

Shermer, *Why People Believe Weird Things.*

Questions to Consider

1. What would you say about the idea that the medical establishment is hiding a cure for cancer?

2. Are there some types of medical myths that doctors themselves are more likely to believe?

3. What false beliefs might you be harboring, and how is it best to deal with them?

Glossary

Myths sometimes stick in the mind even after more accurate information has been presented. For that reason, this glossary focuses on currently accurate medical information pertaining to myths discussed in the course. Each entry also mentions specific lectures where relevant information is discussed or mentioned. As always, for specific medical advice or treatment, consult a physician.

acupuncture: Acupuncture originated from multiple prescientific belief systems, including blood-letting, and its current practice lacks both the long tradition and evidence of efficacy that is widely presumed. There are currently no proven indications for acupuncture. Published scientific evidence shows that acupuncture points have no basis in anatomy or physiology, that needle placement does not relate to effectiveness, that needle penetration through the skin is not necessary, and that the training or experience of the acupuncturist does not affect outcome. What does impact outcome is the compassion and interaction of the acupuncturist. All of this suggests that acupuncture has no specific biological effect but is essentially a ritualized placebo intervention (Lecture 17).

amnesia: Amnesia is a loss of memory, which can be either temporary or permanent. Amnesia for events occurring prior to an injury or other cause is called retrograde amnesia; for events after an injury, it is called anterograde amnesia. Amnesia never causes one to forget one's name or identity—such a state is a psychiatric condition known as a fugue state (Lecture 20).

animal magnetism: Animal magnetism is a term invented by Franz Anton Mesmer in the 18th century, which he used to refer to a hypothetical magnetic fluid that he claimed existed within living creatures. He claimed to manipulate this force of nature in order to effect cures of his clients. Mesmer was eventually exposed as a fraud, and the notion of animal magnetism never caught on as a scientific concept. However, the term survives with a very different colloquial meaning (Lecture 18).

antibiotics: Antibiotics are specific to bacteria and do not work against colds (Lecture 9), other viruses, or other types of germs. Use in animals is not directly dangerous to people, although may hasten resistance (Lecture 5). They may reduce the normal bacterial flora, especially broad-spectrum antibiotics (Lecture 6). Overuse of antibacterial products can cause bacteria, not people, to become resistant to an antibiotic (Lecture 12).

antimicrobials: Antimicrobials are drugs that are used to treat infecting organisms, such as viruses, bacteria, fungus, or protozoans (Lecture 12).

antioxidants: Antioxidants are a class of chemicals that react with oxygen-free-radicals and stop them from reacting with and damaging components of cells. They occur naturally in living organisms (such as vitamins C and E and enzymes such as superoxide dismutase). Claims for antioxidant supplements have generally not been supported by clinical evidence. For example, the evidence does not support claims that antioxidants reduce cancer risk or prolong longevity (Lecture 8).

antivirals: Antivirals are a class of drugs that inhibit reproduction of viruses but do not kill viruses. They are useful in a subset of specific viral infections (Lecture 12).

applied kinesiology: Applied kinesiology (not to be confused with simply "kinesiology," which is the study of human movement) is the technique of using muscle strength testing to diagnose a host of diseases and ailments, including allergies. It is used mainly by chiropractors, but has been adopted by other practitioners as well. Published research, however, shows that applied kinesiology is not reproducible under blinded conditions, and is likely nothing but self-delusion and what is called the "ideomotor effect"—subconscious muscle movements based on expectation (Lecture 15).

attention deficit hyperactivity disorder (ADHD): ADHD is a genuine neuropsychological disorder that is currently considered to be a deficit of executive function and correlates with reduced activity in the frontal lobes. Recommended treatments include prescribed central nervous system stimulants and behavioral management using clear routines, boundaries, and positive reinforcement (Lecture 7).

autism: (Now considered part of autism spectrum disorder.) Autism is a neurodevelopmental disorder characterized by a deficit of social development. While the precise cause is unknown, current evidence strongly suggests autism is largely a genetic disorder affecting brain development. There is no scientific evidence linking autism to a significant environmental factor, including parenting style, specific foods (such as dairy products) or toxins (Lecture 7). Despite some credulous media coverage, multiple studies have failed to show any correlation between vaccines and autism. Also, despite claims by a few, mercury toxicity is a distinct neurological condition that does not resemble autism (Lecture 11).

bacteria: Bacteria are the most populous kingdom of life on earth. Most bacteria do not cause disease or have any implications for human health (Lecture 6). Some bacterial species are actually necessary for health, as they colonize our skin, bowels, and other mucous membranes. Only a small percentage of bacterial species are infectious to humans and can cause illness. Illnesses such as flus and colds are not caused by bacteria, but rather by viruses (Lecture 9). There are vaccines available for certain common and serious bacterial infections. Attenuated bacteria are used in typhoid and tuberculosis (TBG) vaccines, while killed bacteria are used in typhoid, cholera, plague, and pertussis vaccines (Lecture 10). *See also* **probiotics**.

bee venom therapy: Bee venom therapy involves allowing honey bees to sting and inject their venom, which is believed to have anti-inflammatory properties. While bee venom contains many interesting biologically active chemicals, there is currently no evidence supporting the safety and effectiveness for bee venom for any specific disease. Bee stings also come with the risk of serious allergic reactions (Lecture 23).

biofeedback: Biofeedback is a technique of using monitoring of biological functions, such as heart rate or electrical brain activity, in order to achieve a state of maximal relaxation. This can be a useful technique, but there is no evidence for medical benefits beyond that of relaxation (Lecture 19).

blood type diet: Blood type refers to various protein antigens that are found on blood cells and that are reactive to the immune system. The most commonly known (but not only) system is the A-B-O blood type. Individuals will make antibodies against whatever antigen they do not possess themselves, so those with blood type B will make antibodies against type A. Therefore blood typing is essential for matching blood donors, or for any organ transplant.

However, there is no theoretical reason or evidence to suggest that blood type has any other biological significance. There are popular claims that different blood types require different dietary needs for optimal health, but this is not based on any science or evidence (Lecture 23).

bottled water: Bottled water has become a popular product, and many people purchase bottled water for the convenience. However, bottled water varies in quality as much as tap water, and there is no consistent advantage to taste, purity, or healthfulness to bottled water over tap water (Lecture 2).

brain death: Brain death is defined as a complete lack of brain activity, which must be documented to strict criteria either by neurological exam, electroencephalography, or other diagnostic testing. In many states and countries brain death meets the legal definition of death (Lecture 20).

brain usage: Anatomical and functional studies show that humans use their entire brains. Despite the popular myth, we do not use only 10% of our brains and, in fact, it is not possible to be conscious using just 10% of the brain. The source of this myth is not clear, but it is not based on any scientific belief or evidence (Lecture 20).

caduceus: The winged staff of Hermes (with two snakes) is not the official symbol of medicine. This was a simple mistake made by the US Army Medical Corp in the late 19^{th} century and was then perpetuated. The Staff of Asclepius (with one snake) is the actual symbol preferred by medical professionals and now recognized by the AMA (Lecture 23).

caffeine: Caffeine is a widely consumed drug with multiple biological effects. It acts as a mild diuretic, but you can still rehydrate with fluids that contain caffeine. Regular caffeine drinkers become tolerant to the diuretic effect (Lecture 2). While caffeine is a stimulant and can interfere with sleep, its use has not been linked to hyperactivity (Lecture 7).

calories: A calorie is a standard measure of energy. The term "Calorie" (sometimes designated with a capital "C") is also used to refer to a kilocalorie of energy in food (so 1 food Calorie = 1000 calories of energy). And 3500 Calories translates to one pound of fat, which is the body's way of storing energy. Weight control is about the proper balance of total calories consumed versus total calories expended. Overeating by 50 calories per day can mean gaining 5 pounds per year. It does not matter when you eat the calories; late-night eating does not necessarily affect weight (though it can cause problems with reflux; Lecture 4).

cancer prevention: Cancer is not one disease but a category of diseases (also called neoplasms). Therefore there are different methods for preventing and treating different kinds of cancer. Cancer prevention is largely accomplished through lifestyle choices, such as avoiding smoking. The relationship between diet and risk of cancer is complex and still the focus of ongoing research, but in general a diet rich in fruits and vegetables may be of benefit (Lecture 23).

cell phones: Cell phones are a source of nonionizing radiation. This has caused some popular concern about their potential health risks. However, nonionizing radiation (electromagnetic radiation of near-ultraviolet or longer wavelength) is too low energy to break chemical bonds, and therefore cause any direct damage to DNA or other cell molecules (Lecture 18).

chewing gum: Chewing gum is made of indigestible gum resin, but normally passes through the gastrointestinal tract without getting stuck. Not recommended for children under 5 years due to choking hazard (Lecture 1).

chiropractic: Chiropractic is a system of practice originating with D. D. Palmer in 1890s based on notions of life energy. Some chiropractic continues to follow Palmer's unscientific ideas, while others more closely resemble contemporary physical therapy and sports medicine (Lecture 18). Chiropractic generally continues to focus on manipulation of the back to affect the alignment of the vertebra. Chiropractic remains controversial due to the lack of a scientific basis for many of its practices.

cholesterol: Cholesterol is a waxy steroid-like molecule used as a structural component in living cells. It is also a building block of other important substances, and is essential for life. It is transported in various forms in the blood and can build up on the inside of blood vessel walls, eventually leading to plaques and blockages. To minimize cholesterol buildup, it is optimal to keep total cholesterol levels relatively low and to maintain a relatively high ratio of HDL (so-called good cholesterol derived from plants) to LDL (so-called bad cholesterol derived from animal fat; Lecture 4). *See also* **fats**.

chronic fatigue syndrome: This is a controversial disorder characterized by a state of chronic fatigue without any identifiable causes. In a minority of patients with chronic fatigue a chronic infection with the Ebstein-Barr virus (EBV) has been identified and is considered a plausible cause. However, many people without chronic fatigue are EBV positive, and many people with chronic fatigue are EBV negative. Therefore there may be other unrecognized causes. In addition, patients with chronic fatigue may simply have a known but currently undiagnosed condition to explain their fatigue (Lecture 13).

chronic Lyme disease: The term "chronic Lyme" can refer to chronic symptoms following an acute infection with the bacterial spirochete *Borrelia burgdorferi*. However, there are patients and practitioners who believe that it is possible to have a chronic active infection with *B. burgdorferi* that survives even thorough antibiotic treatment. This claim remains controversial and without empirical evidence (Lecture 13).

coma: Coma is a term used to define a disorder of consciousness caused by damage to or physiological impairment of the brain. For nonreversible causes of coma, patients rarely "wake up" without neurological impairments. Conscious processing (seeing/hearing) is unlikely in persistent vegetative state (PVS) but may occur in a minimally conscious state (MCS)—although currently there is little difference in prognosis between PVS and MCS (Lecture 20).

common cold: The common cold is an upper respiratory infection caused by many different viruses. Cold weather does not cause colds; it is possible to catch a cold in the summer. Vitamin C, Echinacea, and supplements like Airborne will not prevent or treat a cold. There is nothing special about chicken soup, although hot liquids may provide some symptom relief (Lecture 9).

copper: Copper is a nonferromagnetic base metal (it cannot contain a magnetic field). There is no evidence of benefits for pain or other indications from copper jewelry (Lecture 18).

dehydration: Dehydration defines a relative lack of water in the body. Most people in most situations can maintain proper hydration simply by drinking when thirsty. Drinks with caffeine do not worsen dehydration (Lecture 2). In extremely hot or dry environments, at high altitudes, and with extreme physical exertion special effort may be required to stay hydrated. Looking at the color of your urine is one way to quickly assess your level of hydration. *See also* **water**.

detoxing: The human body's inherent ability to remove toxins is often sufficient (kidneys, skin, and breath). Drinking lots of water does not "flush out" the system. Although this is a common claim, there are no diets or supplements which have been shown to aid dotoxifying the body (Lecture 16).

diabetes mellitus (DM): Diabetes mellitus is a group of disorders of glucose metabolism. Adult onset DM is often due to a combination of genetic predisposition and being overweight or obese. Diet is also important, specifically avoiding foods with a high glycemic index (GI), meaning that they are rapidly converted into glucose (Lecture 4).

dieting: Special diets are sometimes required for specific health conditions, like diabetes and heart disease. However, for weight control and overall health it is recommended to adopt healthy eating habits and lifestyle for life, rather than going on a restrictive or crash fad diet. Fasting is also of no long-term benefit. Diet pills do not aid in long-term weight control and may be harmful (Lecture 4). *See also* **calories.**

disorder: A condition characterized by the lack or impairment of a function usually possessed by healthy individuals and resulting in demonstrable harm. A disorder is distinguished from a disease, which has a specific demonstrable pathology (Lecture 13).

dying in dreams: Although there is a common belief that dying in one's dream will cause one to die in real life, there is no evidence to support this. Dreaming of dying is not uncommon, and if someone did in fact die from a dream they would not live to tell about it. Even if later revived, they would likely not remember the event, given that the process of dying and being resuscitated would likely lead to brain anoxia and therefore lack of memory of the event (Lecture 24).

facilitated communication (FC): FC is a disproven technique developed in the 1980s involving a facilitator who will aid a client who is not able to communicate on their own by "helping" them move their hand across a keyboard or other pointing device. Early popularity among therapists gave way to carefully controlled scientific studies that clearly indicated that the facilitator was doing all the communication, not the client. FC is now known as an example of the ideomotor effect in which a person makes small subconscious muscle movements, such as during the operation of a ouija board. Despite scientific evidence that FC does not work and is a deception, it remains in use by fringe practitioners (Lecture 20).

fats: Fats, or lipids, are one of the macronutrients from which we derive much of our calories (energy) and are also essential building blocks for life. However, too much of the wrong kinds of fats can increase disease risk, especially vascular risk. So-called "good" fats are monounsaturated and polyunsaturated fats that increase high-density lipoprotein (HDL) levels. The term HDL refers to the size of fat globules in the blood, and they are "good" because they shuttle fat and cholesterol from the lining of blood vessels to the liver. "Bad" fats are saturated fats and trans-fats which increase low-density lipoprotein (LDL) levels. LDL contributes to fat and cholesterol deposition in the blood vessels (Lecture 4).

fever: A fever is an abnormal increase in body temperature. 98.6° F is not the normal temperature for everyone; that number is based merely on an average computed in the 19th century. There is a range of normal body temperature, and the cutoff for a fever is a temperature over 100 degrees F. Most fevers do not pose any health risk (unless they are very high, 107 degree F or greater), and therefore the only need to treat them is for comfort (Lecture 9).

flu vaccine: The flu is a severe upper respiratory infection caused by various strains of influenza virus. Vaccines made from either attenuated or inactivated versions of flu viruses have been shown to be effective in reducing the risk of getting the flu and morbidity from the flu. Despite some claims, flu vaccines do not contain aborted fetal cells (Lecture 10).

genetically modified (GM) food: Genetically modified food refers to cultivars of edible plant and animal species that are the result of direct genetic manipulation. This involves either inserting a gene from another variety, or even species, or modifying existing genes. Critics claim that GM foods are inherently risky and have not been adequately safety tested. Supporters point out that all foods consumed by humans have been substantially modified over centuries and millennia with breeding and cultivation, and GM simply speeds up this process (Lecture 5).

hangover: Hangover refers to a set of symptoms, including headache, dehydration, and nausea, caused by the after effects of alcohol toxicity, and is the target of many popular, but untrue, preventions and remedies (Lecture 1).

head injury: A head injury serious enough to cause unconsciousness is also likely to cause long term or even permanent brain injury (called traumatic brain injury). Unlike in the movies, someone suffering a blow to the head that causes unconsciousness does not simply revive minutes or hours later with no long-term impairment (Lecture 20).

heat loss through head: This notion is inaccurately based on the idea that heat rises (heat has no tendency to rise, although some hotter fluids, like air, will rise above relatively cooler fluids). Heat is lost through entire surface area of skin through radiation and evaporation, and is affected by various factors, including blood perfusion and exposure (Lecture 24).

herbal treatments: Herbs have been used for millennia as drugs and remedies, and are an important source of modern drug development (pharmacognasy). However, while they are used for their pharmacological effects, they are often poorly regulated as dietary supplements (Lecture 14).

hiccups: A hiccup is an involuntary contraction of the diaphragm resulting in a sharp intake of air followed by a glottal stop. There are countless folk remedies, none of which work but may appear effective because most hiccups stop even without intervention (Lecture 1).

HIV and **HIV prevention**: The human immunodeficiency virus (HIV) is the virus which causes the acquired immunodeficiency syndrome (AIDS). Preventing the spread of HIV is a major goal of the world's health organizations. Their efforts are sometimes hampered by myths about HIV and prevention, including the myth that HIV is not the true cause of AIDS (Lecture 23).

homeopathic products: Homeopathy is a prescientific medical philosophy dating from the late 18th century. Its premises or "laws" are fanciful and not supported by modern science. They include using substances diluted to the point where not even a single molecule remains. Claims for homeopathic products have been shown in clinical trials to be no different from placebos. Homeopathy does not refer to herbal or natural remedies (Lecture 15).

honey: Honey is highly concentrated flower nectar made by honeybees. Its extremely low moisture content makes it an effective antiseptic for wounds (Lecture 12).

hormones in meat and dairy: Natural and synthetic hormones are used to increase growth and production. Small amounts can be found in beef, slightly more in eggs and dairy, but overall levels of added hormones are much less than naturally occurring hormones in people and animals. There is no current evidence for adverse health effects (Lecture 5). *See also* **antibiotics**.

hyperactivity: Although normal in children to some extent, increased hyperactivity is considered a disorder and may occur with or without attention deficit. Hyperactivity is often erroneously linked to food as the cause, particularly sugar, caffeine, or preservatives but scientific studies do not support a causal link (Lecture 7).

hypnosis: Hypnosis is not a trance but rather a state of heightened alertness and suggestibility. People are capable of lying when hypnotized. Hypnosis does not grant access to otherwise forgotten memories and, in fact, may result in the formation of false memories. There is evidence to support medical use of hypnosis for pain, blood pressure, stress management, and muscle relaxation—essentially using hypnosis as a form of relaxation (Lecture 19).

infrared lasers: Infrared lasers refer to coherent light in the infrared spectrum, which is efficient at transferring heat. They are legitimately used to relax muscles, which is a response to the heating effect (Lecture 18).

ionized water: All water contains ions of H+ and OH- in a steady state. The balance of these ions in water determine the water's pH. Technically pH is a logarithmic scale of the H+ concentration in water, with a pH of 7 being neutral, less than 7 being acidic, and greater than 7 being alkaline or basic. So called "ionized" water has no health benefit over nonionized water. The term "ionized water" is not an accepted scientific term but rather is used in marketing. Pure water always has a pH of 7 and cannot be "ionized." Water may contain ions of other substances, and it is they that make water acidic or alkaline. There is no health benefit to consuming "ionized" or alkaline water, as is sometimes claimed (Lecture 2).

iridology: Iridology is a form of diagnosis based on the false notion that the colors and flecks in the iris of the eye are connected to all parts of the body and reflect the health or disease state of the body. Practitioners therefore claim to infer a person's state of health by looking at the iris. This idea, however, is not based on any known anatomy or physiology, nor is there any evidence for its claims (Lecture 19).

irradiated foods: Irradiated foods are those that have been treated by passing radiation through them in order to kill any bacteria or other organisms. The food is therefore sterilized, which greatly reduces spoilage and extends safe shelf-life. Irradiated foods are not radioactive (Lecture 5).

kidney stones: Kidney stones are formed from solid concretions or small crystals forming from substances dissolved in urine. Some individuals are predisposed to kidney stones due to genetics or certain medications or chronic medical conditions. Drinking enough fluid helps keep the urine dilute and washes out any small crystals or concretions before they form into stone (Lecture 2).

knuckle cracking: Knuckle cracking is the process of making a popping sound by stretching the joints, thereby expanding the synovial fluid which forms bubbles that then "pop." This activity has not been linked to arthritis; but in one study was shown to be associated with some loss of strength in the hands, perhaps due to lax ligaments (Lecture 24).

locked-in syndrome: Locked-in syndrome is a syndrome in which a person is mostly paralyzed but still fully conscious. This may result, for example, from a brainstem stroke or other injury that causes a person to be paralyzed everywhere except for some remaining eye movement. Some patients who are locked in may communicate by blinking their eyes or by computer tracking of their gaze (Lecture 20).

low fat versus low carb: *See* **dieting.**

magnets: Most magnets are permanent magnets, which are made by ferromagnetic material, like iron, being exposed to a magnetic field while being stroked or struck. Static magnets, like refrigerator magnets, have a static (unchanging) magnetic field. There is no demonstrated biological effect or medical benefit for static magnets, despite centuries of products with such claims. Dynamic magnets, however (such as electromagnets with an alternating magnetic field), do have biological effects and may have potential benefit for migraine and other indications (Lecture 18). *See also* **cell phones** and **copper.**

meditation: Meditation is a self-induced state of relaxation. This may be achieved through self-reflection, rhythmic chanting, or "mental silence." There is no consensus on a more specific neurological definition. Meditation is useful medically to achieve relaxation, reduce pain, and lower blood pressure or stress, but evidence is lacking for applications not related to relaxation (Lecture 19).

microwaving: Microwave ovens use microwave frequency electromagnetic fields to heat water molecules inside food. This has the same overall effect on food as other forms of cooking. Using microwave-safe plastic containers does not release cancer-causing toxins, although not all plastic is safe to microwave (some are too thin and might melt; Lecture 16). Microwave ovens are shielded, but to minimize potential risk do not stand directly in front of microwaves for extended periods. Liquids may become superheated in a microwave causing rapid boiling and pose a burn risk (Lecture 18).

migraines: Migraines are a chronic neurological disorder characterized by recurrent headaches, often associated with nausea and sensitivity to bright lights and noise (Lecture 2). Many migraine sufferers require medications to prevent and treat headaches. Several nutritional supplements, such as Vitamin B2 and magnesium, may aid in prevention (Lecture 3).

minerals: Minerals are required, often in trace amounts, for normal health. Plants require minerals also, and humans derive much of their minerals from plants in the diet. Reports of mineral depletion in soil are often misinterpreted. Soil is tested and minerals are added during farming, and mineral content in food is generally adequate (Lecture 3). *See also* **vitamins.**

minimally conscious state (MCS): MCS is a type of coma characterized by severe decrease in consciousness with only minimal signs of any interaction with the environment. MCS is the result of severe brain injury and has a very poor prognosis but slightly better than persistent vegetative state (Lecture 19). *See also* **coma** and **persistent vegetative state**.

morbidity: The term morbidity refers to disease, injury, illness and other biological adverse conditions, events, and effects. The term “mortality” specifically refers to death, and therefore “morbidity” is often used in medicine to refer to all diseases and adverse consequences short of death.

natural: The term “natural” refers to substances that occur in nature, but in terms of food and products the definition is often vaguely applied and not carefully regulated. "Natural" is used more as a marketing term than for any meaningful scientific definition (Lecture 5).

neti pot: A container used to flush the sinuses with warm water or saline (salt water). While use may improve an acute sinus infection by helping to remove mucous, there is no evidence for benefit from routine preventive use, and in fact frequent use may lead to sinus infections.

organic foods: The term "organic" refers to a collection of farming practices that avoids the use of synthetic fertilizers and pesticides and the use of other techniques such as irradiation and genetic modification. The regulation of the organic label refers to the process of farming and production, and does not necessarily say anything about the final product. Proponents argue that organic farming methods are more sustainable and better for the environment, while others argue that sustainable farming methods should be supported whether or not they meet the definition of "organic." Some may prefer organic produce because they wish to support local farms, although much organic farming is conducted by large agricultural companies as well. Claims for nutritional or health benefits of organic produce remain somewhat controversial. After 50 years of research there is no evidence of a specific health benefit to consuming organic food. Organic produce does contain fewer synthetic pesticides, but the health implications of this are unclear as pesticide levels are generally low (and can be reduced further by thorough washing) and organic farming often uses nonsynthetic pesticides. (*See also* **hormones**.) There are only slight nutritional differences in organic versus conventional produce, with unclear impact on nutrition and health. An additional concern for organic meat, eggs, and dairy is the humane treatment of the animals in question (Lecture 3).

persistent vegetative state (PVS): A type of coma defined by a complete lack of any interaction with the environment. People in a PVS can have sleep-wake cycles, and display eye movement, facial grimacing, and other movements but have no discernable conscious awareness. PVS is usually the result of severe permanent injury to the brain (Lecture 20). *See also* **coma** and **minimally conscious state**.

pharmacognasy: The study and development of medicinals from natural substances, such as plants and animals products. This has been and remains an important part of modern drug development (Lecture 14).

placebo effect: There are many types of placebo effects which cause the impression or illusion of a health benefit from an inactive intervention. These effects include psychological effects, nonspecific benefits surrounding the ritual and attention of treatment, biases of observation, and statistical effects (like regression to the mean; Lecture 21).

prebiotics: Prebiotics are foods that contain nondigestible components that are meant to be food for intestinal bacteria in order to support the intestinal ecosystem. While theoretically plausible, there is currently no evidence to support specific health benefits (Lecture 6).

pregnancy, conception: Conception is the result of the union of male and female gametes. There are many myths and beliefs surrounding this event—most involving methods of preventing, ensuring, or controlling conception so as to determine gender (Lecture 22).

pregnancy, determining gender: The two scientifically established methods of determining the gender of a child prior to birth are through examination of the anatomy by ultrasound or examination of the genetics through amniocentesis (Lecture 22).

pregnancy, labor: Having a safe and healthy pregnancy and delivery is important, but many myths as to how to achieve this may cause unnecessary fear. It is best to listen to expert advice. For example, it is safe to sleep on one's back while pregnant. Raising arms will not twist the umbilical cord; moderate exercise is okay; bumpy roads will not induce labor; and it is safe to use microwave ovens (though don't stand close for long periods while they're operating; Lecture 22).

prepared foods: In terms of nutritional content, food choice is overall more important than food preparation. Excessive cooking can reduce the nutritional content of food, but normal cooking will have a negligible effect. Fresh fruits and vegetables will often have the most nutrients, but frozen may in fact be better as frozen produce is often picked at peak ripeness, while canned has slightly less (Lecture 3).

probiotics: Probiotics are products that contain live bacteria, intended to improve the helpful bacterial flora of the body, mainly in the intestines. Existing products, however, have not been shown to significantly alter the complex bacteria ecosystem of the body, with either short-term or long-term use (Lecture 6).

raw foods: Raw foods refers to food that has not been cooked or treated in a way that would alter its composition. Despite claims, raw foods are not nutritionally superior to cooked foods. Normal cooking only has a minor effect on some nutrients, while actually making some foods more digestible and therefore more nutritious. Raw milk has no more nutritional value than pasteurized and carries an increased risk of contamination and infection (Lecture 5).

sneezing: A sneeze is an involuntary reflex that results in the explosive expulsion of air from the lugs through the nose and mouth. It is possible to voluntarily suppress a sneeze. Despite common belief, this is not dangerous. However violent sneezing itself does have some rare risks, including muscle strain, arterial dissection, and venous thrombosis (Lecture 1).

sweating: Sweating is the secretion of water through sweat glands in the skin. Its primary function is to cool the body through evaporation. If one becomes dehydrated the ability to sweat will be diminished, which can lead to overheating (Lecture 2).

swimming: Swimming is a physical exercise like any other. There is no special reason to wait an hour after eating before swimming, although any physical exertion on a full stomach may be uncomfortable (Lecture 1).

syndrome: A syndrome is a constellation of symptoms and signs that tend to occur together and display a characteristic natural history, prognosis, and response to treatment. Syndromes can be described and named even in the absence of knowledge of their underlying cause, and in fact may have many possible underlying causes (Lecture 13).

teething: Teething is the process of infant teeth emerging through the gums. Infants may often become fussy from the discomfort. However, there is no evidence to support an association between teething and diarrhea, cough, or high fever (Lecture 24).

turkey: Turkey meat is a source of protein, including the amino acid L-tryptophan. It is a popular belief that tryptophan contributes to the sleepiness attributed to a large turkey meal, however tryptophan from turkey alone does not cause sleepiness (Lecture 24).

urine therapy: Urine therapy (or urotherapy) is the practice, dating back to many ancient cultures, of drinking one's own urine as a remedy or health tonic. It is based on the false belief that vital nutrients or therapeutic proteins are expelled in the urine and drinking them can cure many diseases or ailments. However, this is superstition and not science. Urine is waste and is used to remove toxins and waste from the body as well as to regulate electrolytes and hydration (Lecture 23).

vaccination: Vaccination is the medical intervention of stimulating the immune system with a component of an infectious agent in order to provoke long term immunity to the infection. Vaccines use either live attenuated (not harmful) versions of bacteria or viruses, or killed organisms, or sometimes just proteins from the organisms. In this way vaccines strengthen the immune system and allow it to mount a much more vigorous response when the recipient is exposed to the infecting agent the next time (Lectures 10 and 11). *See also* **flu vaccine** and **autism.**

vitalism: Vitalism is an ancient belief, common in almost every culture, that living things are animated by a life energy. In Chinese culture the vitalistic force is referred to as chi (or qi), in India it is called prana, while in the West it was referred to as spiritus and in modern manifestations it has been called "innate" (by chiropractors) and the "human energy field" (by practitioners of therapeutic touch). The vitalistic force was used to explain aspects of biology that were not yet understood scientifically, but by the middle of the 19th century the notion of a vital force was abandoned by science, essentially because there was nothing left for it to do (biological processes had been adequately explained scientifically to make it superfluous). Further, there is no scientific evidence for a special life energy or any claims based on its manipulation (Lectures 15 and 17).

vitamins: Nutritional substances essential to health in tiny amounts that an organism cannot manufacture in sufficient quantities, and therefore must be obtained from the diet. There are deficiency syndromes associated with each vitamin, which can be treated by supplementation. Overdoses of specific vitamins are also possible. A balanced diet can be sufficient for most people to provide enough vitamins without the need for supplements. Women who are pregnant or may become pregnant should be taking a prenatal vitamin, especially folic acid. Other specific medical conditions may also benefit from specific vitamin supplements (Lecture 3).

water: Water is the most fundamental component of life, and also a target of much misinformation. All life requires water to live, and the average person could only survive a few days without access to water. However, 8 ounces of water 8 times per day is not a rule based on any evidence. For most people in most situations thirst is an adequate guide to hydration (Lecture 2). *See also* **dehydration**.

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